Department of Agriculture, Madras

A POPULAR ACCOUNT

OF THE WORK OF THE

MADRAS AGRICULTURAL DEPARTMENT

MADRAS
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PREFACE.

THE first visit made to the Agricultural College and Research Institute by the Hon'ble Rai Bahadur K. Venkata Reddi Nayudu Garu after becoming Minister for Development Departments so impressed him with the value of the work being done by the expert officers there that he asked each of these officers to write a short account of the work of his section.

Later on, I was asked to edit these so that a popular account of this work might be made more widely known.

It was suggested to me, however, that this account should include the work of the whole Department, not only at Coimbatore, but throughout the Presidency, and that an attempt should be made to form some estimate of the value to the country of the work which has been and is being done by the Agricultural Department.

I wish to acknowledge here the help and assistance given by every one in the Department to make this account as complete and accurate as possible.

CAMP, KOILPATTI,
23rd June 1922.

H. C. SAMPSON,
Offg. Director of Agriculture.

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A POPULAR ACCOUNT OF THE WORK OF THE MADRAS AGRICULTURAL DEPARTMENT.

CHAPTER I.

INTRODUCTION.

In attempting to give a popular account of the Madras Agricultural Department and its work, it may be as well first of all to consider why an Agricultural Department is necessary.

2. It was well pointed out in a recent report that there are three stages of advance in the history of cultivation in India. The first, and most primitive method, is that of clearing and burning an area of forest, and raising one or two crops in the clearing, and then moving on to repeat the operation elsewhere as soon as the primitive fertility is exhausted. This method is extraordinarily wasteful, and with increasing population soon results in the destruction of large areas of forests. It was probably once widely spread in Madras, but has now become rare except in the Agency tracts and in parts of the West Coast and the Nilgiris. In the last district, one still sees the Badagas and Kotas cultivating what is known as "Kaduholu" land or the plateau in the most casual manner. The consequence is that wretched crops are obtained and the top soil is rapidly washed away by the monsoon rains and carried down to the plains below by the river Cauvery, and all that is left is patches of sub-soil, an infertile, stiff, red and yellow clay.

3. This form of cultivation was well suited to wandering tribes when the world was young and the population small. At the second stage, settled cultivation replaced this shifting cultivation as the population increased and communities were established to settle in definite places and form villages instead of wandering. But the cultivator still relied on the forest for replenishing the fertility of his cultivated lands. This was done either directly by removing leaves and bushes from the

forests, or indirectly by grazing cattle and goats in the forests and applying their manure to the cultivated fields. As population increases, and with it the area cultivated, a stage is reached at which the forest areas which are left begin to deteriorate rapidly. The process is an accelerating one. As the area of cultivation expands, the area of forests must diminish, and the demand on this diminished area becomes greater and greater. If this process were allowed to continue unchecked, the ultimate result would be the destruction of all forests. In a locality like the Attur taluk (Salem), for instance, over 28,000 acres are cropped under paddy every year, and each acre under this crop requires four acres of forest area to yield sufficient leaf for manure, and this can only be taken once in four years. The total area of forest in this taluk is only about 72,000 acres, so that the whole forest would not be able to meet even a year's demand for leaves. For the permanent supply of leaf manure, a forest area of over 400,000 acres would be necessary for this taluk only. Hence we see the need for the Government protection of forest areas as the agricultural population increases and settles down, and the necessity for the birth of a Forest Department.

4. During the course of the process described above, certain tracts of cultivation found themselves out of reach of any forests or waste lands. The cultivators of these tracts were, therefore, forced to progress to a third stage of conservative cultivation; they had to devise a system of cultivation which would maintain the fertility of their lands based on their own resources and without reliance on any outside sources of manure. It is obvious that this can be done in any tract only so long as the essential fertility of the soil is not exported in any form. Every part of the crop which is derived from the soil, and not from the air and water, must go back to the land. If any phosphorus in grain leaves the country, either directly as an export, or indirectly through the wasteful methods of sewage disposal, then the phosphorus should be replaced by the importation of an equivalent amount in the form of fish manure, bird guano, or rock phosphate. Legitimate exports are, therefore, oils and cotton lint, hides and skins, as these are derived ultimately from the air and not from the soil. Oil-cakes and bones should be retained in the

country as these contain phosphorus derived from the soil.

5. In the case of rice cultivation, large quantities of organic material are required each year to provide a proper basis for the processes of bacterial fermentation which go on in paddy soil and which are essential to the growth of the plant. These organic materials are carbo-hydrates, derived solely from the air and water, and so can be grown anywhere.

6. In Madras, very large areas of paddy land have reached this third stage of conservative cultivation. This is especially the case with the large deltaic areas which between them account for some three millions out of the eleven millions of acres annually grown with rice in the Presidency.

7. At this stage in the history of agriculture, we see the necessity for an Agricultural Department equipped to study the various problems which at once arise, and to introduce and teach new methods and improvements to the ryots. Such problems are many ; already we have indicated problems of manures and their conservation, the supply of organic material to improve the texture of the soil, and the study of soil problems and bacterial processes taking place in the soil. As soon as populations settle down and agriculture becomes fixed over large areas, other problems at once arise, such as, what are the best crops to grow, what are the best rotations, the best method of cultivation, the best varieties to use. Again, as soon as large areas of land are put under one crop, diseases and crop pests will make their appearance and the control of these must be studied.

8. A good farmer may be described as one who is not content merely to maintain the fertility of his land, but who, by the wise and economical expenditure of money and labour, builds up the fertility of the soil and recoups himself for that energy and expense by the enhanced crop returns and the increased value of his land. It is only by such progressive methods that farming, so frequently and correctly described as the backbone of the country, can hold its own against other industries and retain brains, men, and money to feed successfully a great and growing population.

9. What are the means by which enhanced crop returns and increased and increasing fertility of the land are obtained? They are—

(1) Improving the soil itself by such processes as manuring, liming, draining, levelling, and embanking.

(2) Improving the conditions of plant growth by clean and careful cultivation, and providing or conserving a sufficiency of moisture in the soil.

(3) Improving the kinds and varieties of crops grown, and selecting strains which can make the best use of the conditions present.

(4) Improved methods of performing any of the above operations, whether for quality or quantity, and the preparation of produce for the market.

Consequently, there is a need for an Agricultural Department which is prepared to deal with all these questions. That the Madras Agricultural Department has to deal with a very large number of problems will be at once realized when we consider that the Presidency comprises an arable area of 39 million acres, varying from sea level to an elevation of 7,000 feet or more, and an agricultural population of over 29 millions. A very large number of different crops is grown and each crop and each district presents its own special problems. The Department is equipped with a staff of special experts, agriculturists, chemists, botanists, entomologists, mycologists and others, whose head-quarters and laboratories are at the Agricultural College and Research Institute at Coimbatore, and also with a large number of officers in charge of district work, where experimental stations are established and local problems are investigated. Attached to each district officer's staff is a number of demonstrators who teach the ryots in person on their own lands new methods and agricultural practices discovered by the Department as a whole.

10. Both sides of the work of the Department, the research side and the district work, will be described in certain of their aspects in the following pages, but before attempting this, it is desirable to emphasize the fact of the continuity of the Department as a whole. The "man in the street" is sometimes apt to look upon experts as a class apart and to think that their work has nothing to do with that of the district officers; and certainly nothing to do with the humble demonstrator

whom he may see at work in the villages. He is apt to think that the two are separate entities and that one might possibly be abolished without its making any difference to the efficiency of the body corporate. This, however, is entirely an erroneous impression and arises no doubt from the difficulty of understanding, or for that matter appreciating, the work done by the expert. The latter is perhaps apt to be a man of reserve and is pictured as living in a laboratory among a lot of bottles and queer smells, or spending most of his time looking down the tube of a microscope, and what he is doing and what it is all about is difficult to understand. Yet, nothing is done within the walls of the Research Institute among the mysteries of laboratories filled with bottles and smells, but may one day filter steadily down through district officer and farm to demonstrator and ryot, and find a practical result and justification by producing "two blades of grass where but one grew before."

11. Has the reader ever thrown a stone into a dense mass of sensitive plant by the road-side and watched the impulse to close its leaves spread outwards from the point of impact till on the edge of a big circle it makes a fringe with here a point running out and there a lagoon mysteriously left untouched, now apparently all action over and suddenly movement starting up again in a new place? So an agricultural problem taken up by research workers starts off an impulse of knowledge which spreads outwards and gradually involves the whole Department, spreading to the farms for trial as experiments, and then to a trial on a field scale, till in the form of definite practical recommendations it is carried to the ryots in some quiet village in the most remote corners of the Presidency by a band of demonstrators contending with difficulties; the ignorance and illiteracy of the people, the systems of land tenure, the conservatism of the ryot, the distrust of anything new and of Government officials, adverse seasons and climate, with the result that here there are successes and there failures, now progress seems to have halted, again it jumps forward with a sudden spurt, here areas are left untouched due to want of staff and money, there unexpected success enables knowledge to be carried over an outlying district.

12. It is to the expert staff at Coimbatore that we have to look for things that the hard-worked district officer has not the time, or perhaps the training, to go into, e.g., analysing the soil and the manures that are to be applied to it ; producing strains and varieties of crops that are going to make the best use of these soils and manures, and protecting the crops from insect and fungus damage during growth, until finally the harvest is triumphantly reaped, with—one must add, sometimes sorrowfully,—the consent of the weather, whereas it should be in spite of the weather.

13. The Agricultural Chemist working in his laboratory and analysing soils gives us an indication of the wants of any particular soil. A soil survey may show that in some places phosphoric acid is wanting, or in others that nitrogen is deficient, and thus a general indication of the requirements of the soils is obtained. Based on this information, experiments on definite lines can be conducted at once, whereas if this information was not to hand, it would have to be found out by a long series of experiments which would cost both time and money.

14. Cholam is often attacked by a smut, a fungus which destroys the grain and causes a considerable amount of loss. The Mycologist in his laboratory discovered that this fungus is carried over from crop to crop by the seed, and that if the seed is soaked in a solution of copper sulphate before it is sown, the fungus spores are killed and the crop protected.

15. Besides dealing with the soils themselves and the prevention of disease in crops, we have other specialists like the Economic Botanist, the Sugarcane Expert, the Cotton Specialist, and the Millets Specialist who are engaged in producing strains of paddy, sugarcane, cotton, cholam and other crops, which are capable of producing a larger amount of crop and consequently more value per acre.

16. At one end of the chain are the experts in their laboratories at Coimbatore linked up with the district staff, deputy directors, assistant directors, farm managers and demonstrators, and at the other end is the ryot himself for whose benefit all the work is done. The man most closely in touch with him is the agricultural demonstrator and as an example of the sort of work he

does day in and day out throughout the year, we take the following extract haphazard from a monthly report: this illustrates how the knowledge obtained originally in the laboratories at Coimbatore, after trials and tests on the farms, is finally imparted to the actual cultivator in his village:—

"The district officer interviewed the Tahsildar who "was camping in the village and advised the ryots about the "use of copper sulphate as a remedy for cholam smut diseases. The village Reddi undertook to sell copper sulphate "on behalf of the Department and he was supplied with 250 "packets of the chemical for this purpose. He also made "arrangements for the sale of N. 14 cotton seed for a fairly "large area. From M— he went to T— and, accompanied "by the Tahsildar, inspected the groundnut crop of four "acres which had been attacked by hairy caterpillars, and "demonstrated to the ryots the advantages of hand-picking "these caterpillars. He spoke to the ryots also about the "use and importance of seed selection and the use of copper "sulphate. The same night he went to R— and interviewed "the Revenue Divisional Officer and proceeded to V— with "him to inspect a few black and red soil villages. He "reached R— the following evening and advised the ryots "about the use of fish guano for their paddy. Some trials "by ryots under his advice of fish guano for irrigated "Cambodia cotton showed that by using a quantity of this "indigenous manure which cost Rs. 15 an increased crop "of 14 maunds of *kapas* valued at Rs. 5 per maund had been "obtained, leaving a gain of Rs. 55."

CHAPTER II.

THE CENTRAL FARM, THE AGRICULTURAL COLLEGE, AND THE RESEARCH INSTITUTE, COIMBATORE.

17. The College of Agriculture and Research Institute is situated a few miles to the west of Coimbatore and can be reached readily by road from that town. It stands by itself in an open compound facing north and is a large and handsome building with its red brick and cut-stone work, the whole surmounted by a clock tower 70 feet in height. A noticeable feature in the landscape, it is a worthy home for the study of the oldest and most universal industry of man.

18. The building itself is two stories high and is built in the form of an H; each block having a verandah on

either side. Its particular feature is perhaps its spaciousness: the central hall on the lower floor being kept perfectly clear and forming a cool and convenient place for such functions as cannot be accommodated in any of the rooms. Behind the building to the south lie the quarters for the staff, with such public buildings as the water works, gas works, and post office,—for the colony that has sprung up around the College is a town in itself—to the west are the rest-house, the farm buildings, and bungalows.

19. Visitors on their first visit are impressed by the size of the building and often when they learn the number of students who are admitted each year make the remark that it seems a very large place to produce such meagre results. This comes from an imperfect appreciation of the work that is proceeding therein. The building is not only a College but a Research Institute, and the actual space occupied by the lecture rooms, museum, and other rooms connected with the teaching of the students, is only a portion, and a small portion at that, of the total area of the building, which also has to accommodate the laboratories of the various research officers, the library, the herbarium, and the dark room. Actually, the building cannot now find the space necessary for these two sides of its activity, and a second building is arising to the south-west of the present block which will be devoted entirely to teaching, with the result that it will be possible to find proper space for the research and analytical staff which is at present more than a little cramped. Indeed, the work has increased so much since it started in 1909, that not only has it been necessary to duplicate the accommodation, but in the two most important sciences on which agriculture is based, viz., chemistry and botany, there have been appointed whole-time teaching professors. It is not the place here to give the details of the work carried out by the various sections: that will be dealt with elsewhere, but briefly the activities of each section are three-fold: research, teaching, analytical or routine.

20. The staff needed for this is naturally a large one, when it is remembered that this Institute and College has to serve the needs of the whole Presidency. Accommodation is found for most of these officers and servants on the estate. Quarters of various types are provided,

from comfortable bungalows for the Imperial officers, to the simple two-roomed cottages of the humblest servants, and lest it should be thought that the Department is unduly favoured and these quarters are an unnecessary extravagance, the visitor will note that all, save the lower paid grades, pay rent for the accommodation they occupy. The advantage of having this expert staff on the spot close to their experimental work, both in the College and in their field plots, is increased by the extremely good health enjoyed by the colony since its foundation.

(A) THE CENTRAL FARM.

21. The Central Farm comprises the estate attached to the Agricultural College and Research Institute, Coimbatore. The object of acquiring a considerable area of land here was to afford opportunities for the students at the College to learn the practice of agriculture, both by example and actual performance, and to provide the necessary land for the field experiments which the staff of the Research Institute has to carry out. It may be said that experiments of this sort would be better carried out in the districts under more ordinary conditions, but this only applies to certain sorts of work. For instance, Dr. Harrison, now the Imperial Chemist at Pusa, made some important discoveries about the nutrition of paddy, a crop of the first importance to Madras, and his experiments had to be done on land close to the laboratories, since a large number of analyses of the soil and water were necessary during the course of the experiment. No doubt much of the experimental work has to be tested on the district farms before its results can be definitely valued, and, if necessary, incorporated into actual farming practice, but there is a great deal which requires, it may be, the co-operation of more than one section, or which needs, like the above, continual laboratory control, and such can only be done on such a farm as this.

22. The actual area of the estate is about 500 acres; of this 45 acres are wet land irrigated by a channel taking off from the Noyil river and devoted to the cultivation of paddy and sugarcane; 124 acres are medium quality black regada soil, and the rest is red soil, partly carrying dry crops, partly garden land under wells, and partly affording sites for the College, the officers' and

students' quarters, and the maidan which serves as the sports ground for the students' club.

23. There has been considerable expansion in both the research and the teaching sides of the College since its first opening, and this has led to such an increased demand for land, both for building sites and for experimental work, that the wants of the students are getting squeezed out and further expansion will no doubt soon be considered. Recently, a Cotton Specialist and a Millets Specialist have joined the staff of the Department and will need space for their work. It is more convenient for them to use the land under the control of the Central Farm as they perforce grow their crops in rotation and would therefore have to take up more land than they actually needed for their particular crop, and would have the trouble of keeping their own cattle and employing their own labour.

24. Two experts have indeed gone outside the Farm but they are both exceptional cases. The Sugarcane Expert has a farm of about 50 acres situated a mile or so away from the Central Farm, but he is an all-India officer and his section is paid for by the Government of India. He wants, however, more land than could have been given him on the Central Farm. The other officer who has gone outside is the Economic Botanist who needed a fair amount of wet land of sufficient uniformity to enable him to lay out plots to test the relative value of his many paddy selections. Space could not be found for this on the Central Farm, nor is the Farm wet land of sufficiently uniform quality.

25. Though the Entomologist and the Mycologist are not directly concerned with the growing of crops, yet they perform experiments on crops and these also are provided by the Central Farm, while space is found for the Insectary and the Mycological Pot-Culture House, where they can grow special plants needed for their work.

26. With all these demands on it, the land now under what may be called ordinary cultivation is proving insufficient to afford practical experience in all farm work to the students. It is not always realized that at this College all students have to attend practical classes and learn themselves to perform all ordinary agricultural

operations: ploughing, harrowing, sowing, weeding, transplanting, harvesting, threshing, feeding cattle, butter-making, and so on. For this, staff, apparatus, and space are required, and on a generous scale. It would be a mistake to confuse them by showing them experimental crops in the first instance. The first essential is that they should learn what, as a result of experience, has been found to be the most profitable way of utilizing the land and the best way to perform the various operations needed in growing and harvesting a crop, and so a good deal of land farmed simply for profit is required. From the careful records kept of the yields and cost of production on this area under normal cultivation, information of great value for theoretical teaching is being accumulated.

27. The activity of the Central Farm centres in the farm yard, where are situated the offices, cattle-sheds, stores, etc. Here will be found three cattle byres, each different in its construction, and serving as an object lesson in the conservation and storage of cattle manure. They were expensive to build no doubt and this criticism is frequently made, but they have had hardly anything spent in repairing them for the last 14 years and look as if they would last a good deal longer yet. Arranged round these sheds, so as to protect them from the wind, are the implement and the grain stores, the latter capable naturally of holding the large quantities of grain which come in at harvest time. The problem of the economical storage of these grains and their preservation from the numerous insects which do so much damage to stored grain, is not the least of those which are receiving attention. The seed which is to be used for sowing the farm lands is threshed separately and receives special attention in a small seed store.

28. Near these buildings, but not in direct intercourse with them, is the Veterinary Hospital for the treatment of sick animals. It was recognized that, if students had to depend on the animals kept on the farm for object lessons in the ordinary ills to which working bullocks are subject, they would not have a very wide range and so a small Veterinary Dispensary has been opened to which our neighbours bring their animals for free treatment, and this affords the students plenty of opportunities. On the other side of the yard is the room for the engine,

a useful demonstration of the many uses to which such a source of power can be put in a farm of this size. Connected with this engine by means of shafting are a chaff cutter to chop the long stalks of cholam into short lengths and thus avoid waste; a cake-breaker to break up the groundnut cake before it is soaked; a cotton seed crusher to crack or kibble the cotton seed before feeding; a threshing machine; and a cotton gin; the whole forming a compact general purpose plant.

29. A short distance from the yard will be found the Dairy, often thought by visitors to be the most interesting place on the farm. Here, students are instructed in the whole business of dairying, the sale of whole and skim milk and the manufacture and sale of cream, butter, ghi and curds. The utmost cleanliness is insisted on, and modern dairy machinery is used; and, in order to dispose of the produce and give the students a real insight into the commercial side of the dairy business, a considerable local and postal trade is carried on. There is a growing interest in milk production in the Presidency and this side of the college training makes a direct appeal to the student and interests him. The dairy herd attached is a very good object-lesson in the yields to be expected from a mixed herd; some of the half-bred cows are really excellent animals. The Dairy just about pays its way, and this, without taking any credit for its instructional value.

30. Of the experimental work that has been initiated on the Central Farm, little need be said. The primary object has been to get definite figures about ordinary farming operations in place of vague statements so that, e.g., a comparison can be made between our practice in irrigation with the practices that occur in other countries, and also with the object of providing material for the lectures on this subject. One experiment may be alluded to as it has given a most excellent proof on one aspect of the modern theory of manuring, namely, that you must supply the particular constituent or constituents of which the crop is in need, failing which no other substances can take their place. The important substance in this case was phosphoric acid, and when this was exhausted by continuous cropping, the crop dropped to a very small average; at present, only those plots which receive

this substance in their manurial treatment give any return at all.

31. Such is the Central Farm and such are its objects, mainly educational, but also, both directly and indirectly, experimental. Lastly, it serves the general convenience and welfare of the estate residents to no small measure. It runs an efficient transport service, a motor lorry, a jutka, a bullock lorry, and single and double bullock carts, between the College Estate and the town; arranges to collect parcels and stores, supplies grains of all kinds from its stores, and generally makes itself useful.

(B) THE AGRICULTURAL COLLEGE.

32. But what of the students? Two courses of instruction are provided for them, a short course extending to two years only and a longer course of three years. Agricultural education, even more than technical education, generally suffers from a multiplicity of advisers: many amateurs think that they can run a farm, still more think themselves competent to organize a course of teaching in agriculture, and there have been many changes. The present short course gives simple practical and theoretical instruction to any one who can understand enough English to follow the lectures and terminates with the Certificate of Proficiency in Agriculture at the end of the two full years. The higher course is intended for students who before entering the College have passed the intermediate examination, and includes, besides instruction in agriculture, a study of the sciences which bear upon it, such as botany, chemistry, mycology, entomology, animal hygiene, and agricultural engineering in all its branches. The question of the affiliation of the College to the University of Madras is now an accomplished fact, and students who succeed in this course are entitled to a Degree of Bachelor of Science in Agriculture.

33. Instruction in both courses includes practical work on the College estate which comprises over 200 acres of arable land representative of the most generally important classes of soil in the Presidency; black cotton soil, red soil, garden lands of varying fertility, and wet land where paddy and sugarcane can be grown. Visitors are sometimes surprised to see how thorough

and complete this practical training is made: students take part in all the work of the farm, feeding cattle, ploughing, harvesting, attending to the sick animals, and later on in the course growing their own crops on their own plots of land. To find room for a hundred and fifty students in this way means a large organization, and for this the Central Farm attached to the College is well suited. Besides these practical field classes, students have other out-door classes: they go to the Botanic Garden and learn the mysteries of gardening, how grafting and pruning are done, how to make cuttings, or prick out seedlings. They are taken out for observation classes to note the progress of experiments, or to see how an insect pest—for like everyone else we suffer from these on the Farm—is kept in check; they may have to attend the Veterinary Hospital which is attached to the Farm where the Assistant in charge will show them how to handle animals, how to dress wounds and administer medicines. In each course he will dissect an animal so that the students may learn at first-hand the structure and functions of the different organs and parts of domestic animals; or they may have a class in the blacksmith's or carpenter's shops, where they are initiated into the mysteries of these crafts and learn to make themselves useful with their hands.

34. Then, of course, there are the lectures in the College and as we have seen there are in the full course a large number of subjects in which instruction is given. The various sections deal with their respective subjects, while, throughout the course, lectures in agriculture explain and elucidate, with the help of models and diagrams, the facts which they have learnt in their field classes and how the sciences which they study are applied to agriculture.

35. It is not an easy course; each section wants to see its own subject taught as thoroughly as possible, and to assimilate them all, needs the best and brightest scholars the country can produce. The students' life here is very full, as we shall see, if we follow them through their day's work. A representative day in a student's life is somewhat as follows:—He starts either at 6-30 a.m. with a practical class on the Farm, or at 7 with a lecture in the College, followed by a demonstration, the class in either case running to three hours,

so that he gets back to his room—each student is provided with a single room, furnished with shelves, chair, and table—by 10 a.m. in time for his bath and morning meal. Meals, it may be remarked, are provided by the hostel organization, and their cost averages about Rs. 20 a month for two substantial and two light meals a day. Classes commence at 1 p.m., this time in the College, and go on till 3 or 4 p.m., one or two different subjects being taken up. Instruction is given by means of lectures so that lecture notes have to be written up after each class and this will provide for a good deal of the evening's work. The student will, however, probably find time to turn out and play some game, cricket, hockey, or foot-ball or put in some time in the library or in the students' club reading the papers and magazines, unless he is due for an afternoon practical class in agriculture which runs from 3-30 to 6-30. Or, he may go and discuss with his tutor his chances of winning one of the College prizes, of which there are a number, or perhaps see the warden or assistant warden about the fitting of his new College coat, for all students wear a uniform dress when attending classes.

36. There is not much time for idling in all this and there is scope for a young man of ability. His prospects of entering Government service at the end of a successful College career are good. The scope for private employment is increasing, while some look to taking up practical farming as a profession and to putting into practice what they have learnt in the class room and on the College Farm.

(C) THE RESEARCH INSTITUTE.

37. Agriculture is an art, based on science. For centuries, India has studied the art of agriculture in the hard school of practical experience and there are few other tropical countries which can equal India in the practice of this art. A knowledge of the sciences on which this art is based provides a short cut to the practice of agriculture and, besides explaining many of the existing agricultural practices, indicates lines on which this practice can be improved. Such indications, however, have to be tested and proved before they can be definitely recommended. Again, many agricultural practices are known by experience to be sound though

the scientific reasons underlying them are often obscure and investigation has to be made to ascertain the why and the wherefore of these. Such investigation will often indicate how such existing practices can be improved upon.

38. Among the greatest difficulties with which a farmer in every country has to contend are diseases and pests. Wherever one sees a promising crop growing in this country one sees also either some figure or painted chatti put up in the crop in order to catch the attention of the passer-by to ward off "the evil eye." The farmer never knows when such a crop may not be damaged by insect pest or disease and superstition has in the past usually attributed such attacks to "the evil eye." Such superstition was prevalent at one time or another in every country, but scientific research has proved that the control of such damage is very largely in the farmer's own hands. It means, however, that careful investigation has to be made into the life-history of insect pests and fungus diseases which attack the crop and the importance of appointing experts for investigating these causes of loss is at once apparent.

39. For these reasons, various scientific officers, each an expert in his own particular branch of science, have been appointed by Government to undertake this research and experiment and, as experience is gained, it has been found necessary to increase the number of such officers.

40. When the Agricultural Department was reorganized in 1906, the number of specialized expert officers was only two, viz., an Agricultural Chemist and a Botanist. It was soon found necessary to appoint an officer for the study of the various crop diseases which are found to cause enormous losses to the farmers of the Presidency. This appointment was followed by that of an officer for the study of insect pests which are also found to cause enormous losses to the country. The damage done by insect pests in Southern India has been estimated to amount to not less than 30 crores of rupees per annum. Following this came the appointment of a Sugarcane Expert. This is an all-India appointment and the necessity for the improvement of this crop was forced on the country on account, not only of the rapidly

increasing consumption of sugar as the prosperity of the country increased, but also on account of the rapid strides which other countries had made in the improvement of this crop. This latter had the effect of so lowering the price of sugar that there was a serious danger of the cane crop disappearing altogether from the country unless the acre yield of sugar produced in India could be improved. This was made an all-India appointment as the menace affected the country as a whole, but the officer was appointed to work under the Madras Government since the south of India was the only part where canes were known to flower, and in order to produce better cropping varieties, it was necessary to raise these from seed. Following this, it was found necessary to separate the duties of the Botanical section as the work had grown too great to be carried on by one officer. Two appointments were therefore made, one of Systematic and Lecturing Botanist who was given charge of all the teaching and the care of the collections in the herbarium, and the other of Economic Botanist, who could devote his time to the improvement of crop varieties by plant breeding. As a commencement, this latter officer took up the rice crop as being the most vitally important crop to Madras. He very soon found that this single crop took up practically the whole of his time and though, in the first instance, he commenced to study cotton as well, he soon realized that, if his work on rice was not to be neglected, he would have to give this up. The value of specializing on one particular crop very soon made itself manifest. Very valuable results have already been achieved, which should add considerably to the food production of the Presidency, and, as a result of this, the question of appointing crop specialists for the study of other important crops of Madras was favourably considered. This ended in the Secretary of State being asked to recruit officers as crop specialists for cotton, for the various dry millets and for pulse crops. The two former of these officers have now been appointed.

41. Recent agricultural research the world over has shown the very important part which bacteria play in agriculture. Some of these are harmful, such as the bacteria which cause "bangle disease" in the potato crop of the Nilgiris, but many of them are of very material

value to agriculture. There are many Tamil and Telugu proverbs which imply that the best manure which can be given to the land is cultivation. Science has shown that this maxim is to a great extent based on the fact that such cultivation provides the proper conditions for the growth of useful bacteria in the soil, many of which are capable of fixing the nitrogen of the air in the ground for the use of the crop which is to follow. As everyone knows, combined nitrogen is not only essential for plant growth, but it is by far the most expensive of all manures. Bacteria also play a very important part in the processes of preparing many agricultural crops for the market. The fermentation of tobacco is an example of this.

42. Much work has been done by the Agricultural Chemist relating to the formation of gases in rice fields during the period of crop growth, and he found this to be due to the action of bacteria. The need of a Bacteriologist to study these and other problems was keenly felt. This appointment was, therefore, sanctioned by the Secretary of State and has been filled.

43. The sanction of the Secretary of State has also been received for the appointment of a Lecturing Chemist. For some considerable time, the work in this section has been more than it could manage and the only satisfactory solution was to divide the work between two officers, and recently a Lecturing Chemist has been appointed.

44. The following is an account of the main features of the work which has been done by each of these sections in the matter of research and service to the general public.

(i) CHEMISTRY.

45. The routine work of this section consists of the analyses of various samples of soil, water, manures, feeding stuffs, etc., which are received either from the general public or from officers of the Agricultural Department and other Departments. For example, the Public Works Department sometimes sends down samples of water for analysis in order to judge if it is fit for irrigation, or what is the quantity and value of silt which is borne in such water. Officers of the Agricultural Department who are in charge of district agricultural

stations frequently need the help of the Chemist in analysing samples of manures, soils, and agricultural produce, or work in collaboration with him when laying down experiments with manures, etc. Other experts, again, may require his help. For example, the Sugarcane Expert requires to know the quality of the new seedling canes produced by him and the amount of sugar which they contain. Close upon 5,000 samples of new seedling canes are analysed each year. In connexion with the Dairy, frequent analyses of milk have to be made. When soil analyses are made for the general public, not only is the analysis given but suggestions are made as to how the land may be improved, what manure should be applied, etc. Such reports are also sent to the Circle officer concerned so that the party may be visited and further advice can be given to him on the spot by one of the district staff.

46. This section has in the past done a considerable amount of investigation regarding the possibility of developing chemical industries connected with the agriculture of this Presidency, and a very large and instructive collection of exhibits was prepared for the Madras exhibition held in 1917 which showed that many of the food products, which could not then be imported from abroad on account of war conditions, could quite well be manufactured in Madras.

47. At the present stage of our knowledge of agricultural sciences in India, the most important line of work in this and in other sections is research, for on this must be based all agricultural improvements. One important line of research has been the soil surveys which have been made in our principal rice areas. These have been completed for the Cauvery delta, and for the area under the Kistna-Gōdāvari irrigation systems in Guntūr, Kistna, and Gōdāvari districts. They furnish very valuable information showing what plant foods are sufficient and deficient in the soil. These have been published as bulletins of the Agricultural Department. In the main, they have indicated that over large areas rice lands are deficient chiefly in the supply of phosphates. In the Cauvery delta, where the soil survey was first completed, very useful results have been obtained from manurial experiments conducted on the agricultural station there and based

on this survey, results which are of the utmost value to the country. Further soil surveys are in progress both under the Periyar irrigation system and in the Malabar district.

48. A very useful and notable piece of research was completed by Harrison and Subrahmanya Ayyar on the gases which are evolved from wet lands when cultivated with rice. This work has clearly shown that the value of green-leaf manure is very largely a matter of its physical action on the soil and that the major portion of the nitrogen, which up to that time had been considered to be the most valuable constituent of such a manure, is lost in the process of fermentation.

49. Much interest has been aroused, not only in India but throughout the world, in the work done on the preparation of cholam malt. The conditions for malting cholam have now been worked out and further experiments in connexion with its utilization are proceeding.

50. Among the main lines of research which are being carried on at present, the following are the most important :—

(1) Conservation and utilization of available manure supplies, which include experiments in the different methods of storing cattle manure and the rate of decomposition of different oil-cakes in varying types of soils, and the action of lime and other substances in accelerating this process. This work is being done in collaboration with the Government Agricultural Bacteriologist and district officers.

(2) Investigation of manurial substances at present unutilized, e.g., mineral phosphatic deposits which are found in large quantities in the Trichinopoly district. This phosphate is found to be very insoluble and experiments, which are leading to very useful results, are being made in order to ascertain how this can be made more readily available. Calcium cyanamide is a nitrogenous manure which in the future may be made available in large quantities when hydro-electric power schemes are brought into being in India. This manure has to be applied with great care because there is the danger of its poisoning the crops. Useful results have already been obtained in solving this difficulty.

Several waste products of agriculture—such as tobacco stalk and paddy husk—are being examined in order to ascertain their manurial value and test methods of utilizing these substances.

(3) A large amount of work has been done in order to ascertain the manurial requirements of the coconut tree by analysing the different parts of the plant in various stages of growth. These have given a very clear idea as to the chief chemical substances which are required by the plant and the indicated information is now being tested in the field at the coconut stations on the West Coast.

(4) A method is being worked out for testing the ripeness of sugarcane *in situ* without having to cut and crush cane and make a trial boiling.

(5) Work has recently been started with a view to ascertaining how far the plant food in the soil accounts for the variations in the quality and length of staple in cotton, as there is considerable variation in these characters when the same seed is grown on different classes of soils.

(6) The improvement of the coconut jaggery industry on the West Coast. The coconut as well as other palms yields a juice capable of producing a very good quality of jaggery. But the jaggery as produced on the West Coast is inferior in quality and will not keep. The reasons for this have been ascertained and methods have been worked out which lead to the production of jaggery of excellent appearance and reasonable keeping quality. A very large number of observations have been made as to the yield of juice from different trees and how the variation is effected by seasons, rainfall, etc. This work will shortly be completed and a survey of the economic position of the industry can then be prepared.

(ii) BACTERIOLOGY.

51. This section has already been in existence for a little more than one year and some useful work is in progress.

52. The Government Agricultural Bacteriologist has, in collaboration with the Government Entomologist, been inquiring into the possible causes of the premature

shedding of cotton bolls and there is evidence to show that this is due—in part, at any rate,—to infection by bacteria, and there are also indications that these bacteria are introduced into the young boll by the agency of various sucking insects which hitherto were not considered as harmful.

53. Biological and chemical analyses of the soil have been and are being made in order to ascertain in what way bacterial activities are essential to the fertility of the South Indian soils.

54. A commencement has been made to determine the conditions under which organisms which are capable of fixing the nitrogen of the air in the soil carry on their work to the greatest advantage. If success is attained in this work, the results will be of the utmost value to the country since combined nitrogen is the most expensive constituent of all general manures.

55. Work has also been started, in collaboration with the Government Agricultural Chemist, to test the various methods of conserving cattle manure and in the preparation of composts which may prove a useful substitution for this.

(iii) BOTANY.

(*a*) Systematic Botany.

56. At first sight, the bearing of Systematic Botany on agriculture may seem to be obscure, but very useful work has been done in studying the habits and conditions which favour the growth of the different grasses which go to make up our grazing areas. This forms a very useful preliminary to the study of the improvement of grazing areas in this Presidency. Much useful work has also been done on the study of the weeds which are found on the different classes of land under arable cultivation. This study shows how such weeds are propagated and how they spread, and furnishes very valuable information to the farmer in indicating methods of cultivation by which they can most effectually be eradicated. A minor line of investigation is the study of plants found in grazing areas which are poisonous to live-stock.

(*b*) Economic Botany.

57. This branch of agricultural research has shown such promise that various specialists each dealing with one important crop or group of crops have been appointed.

(1) *Paddy.*

58. The Economic Botany section was started as a separate section in 1913. Plant-breeding work on paddy as the main crop and cotton as a subsidiary crop was then started. After a few seasons, it was found difficult to combine the two crops and the cotton work was handed over to the Deputy Director of Agriculture, V and VII circles. The plant-breeding work on paddy is now, and has been for several years, practically the sole concern of the section.

59. *Objects of the work.*—The ultimate object of the whole work is to improve the varieties of paddy in general cultivation, the test of *improvement* being an increased monetary return to the cultivator.

60. Several methods of such improvement are being pursued, each with some degree of success:—

(*a*) The improvement of existing varieties by raising pure strains from single-plant selections.

(*b*) The replacement of local varieties by others of greater cropping power.

(*c*) The raising of new strains combining the desirable qualities of two or more varieties by cross-breeding.

To carry out this work with the greatest degree of success, it is necessary to make a close study of the plant, to note the peculiarities of different varieties, to investigate the method of inheritance of important economic characters such as the size of plant, tillering power, duration, size and shape of grain and rice colour, and to discover the connexion between these and other hereditary characters.

61. *Work done.—(a) Fundamental.*—Considerable knowledge has been gained on the points referred to in the last paragraph. An accurate method of testing the yielding powers of different strains has been worked out and adopted. This is a matter of vital importance

as the whole success of the work depends on the accuracy with which the tests are conducted.

(*b*) *New strains.*—A very large number of new strains have been raised and tested along with a number of varieties. Several of these have been proved a success and are being distributed; others are still under trial in the districts or on the Paddy-breeding station.

Of improved strains actually distributed, the following are of chief importance :—

(1) R.S. 76, a strain of *Red Samba* for the Tanjore district; this gives an increased grain yield of 16 per cent over the ordinary *Red Samba* of the district and should replace it entirely. It is being distributed by the district staff and is going well. For the 1919–20 crop, 13,850 lb. of seed were distributed and for the 1920–21 crop, 43,750 lb.

(2) No. 24, raised at Coimbatore.

This is a heavy yielding strain of good quality rice. It is of rather shorter duration than local *Samba* and does not lodge or shed. It is becoming very popular and spreading rapidly round Coimbatore and Erode and has also done well in parts of Salem and Trichinopoly. Many of the ryots who first took it on trial have sold their crop for seed at well over the market rate.

No figures for the area grown can be given as it is spreading naturally and little of the seed now sown is actually distributed by the Department. For last year's crop the whole of the seed available on the paddy-breeding station, just under 6,000 lb., was rapidly disposed of to local ryots.

Of strains under trial, many are undoubtedly very good and their present testing is for the purpose of determining the very best of several related strains before distributions. Thus, for Tanjore, several strains of *Ottadam* have given 10–20 per cent above the local, and of *Nellore Samba* 15–30 per cent increases have been recorded. In each case, the one that is consistently the best for two or three years will be distributed. Similarly, several strains, hybrids of No. 24, are up to 20 per cent better than No. 24 and after this year's final test, the best of these will be distributed.

(*c*) *Future developments.*—It is safe to say that great improvements are possible wherever paddy is grown. In the chief paddy-growing areas, such as the Cauvery and the Gōdāvari-Kistna deltas, plant-breeding work will pay for itself many times over. An improvement of the principal varieties by 10 per cent can be relied on confidently and there is a possibility of 20–30 per cent increase being obtained in many cases. It requires no undue optimism to see the enormous importance to the country of this work.

62. Government have already sanctioned the opening of a paddy-breeding sub-station in Tanjore district for the better prosecution of this work. It is hoped to open a similar station in the Gōdāvari-Kistna delta in the near future as nothing has yet been done definitely for that tract.

(2) *Sugarcane.*

63. As already mentioned, the Sugarcane Expert's is an "all-India" appointment. The work consists of raising new varieties of canes to suit North Indian requirements. The head-quarters of this officer are at Coimbatore and he has up till now worked under the Madras Agricultural Department.

64. The purely botanical work, that of evolving canes superior to the existing kinds, was entrusted to a breeding station, which in November 1912 was started at Coimbatore. The desired result was sought by raising canes from seed instead of from cuttings, a method which had already proved its utility in the other sugarcane countries of the world.

65. The work at the station was quickly concentrated on the breeding of a rather thin type of cane to grow under North Indian conditions, because more than 80 per cent of the Indian cane area lies there, and the class of canes grown there is one of the poorest in the world. So far, very little has been done in the way of producing an improved variety of thick cane for Madras or Bombay. There are indications, however, that this line of work will have to be taken up ere long, as well as varieties resistant to disease.

66. The work accomplished during the period of eight years from the inception of the station has been—

(1) The growing of canes from seed. Though attended with failure on more than one occasion in the past, this was achieved at Coimbatore some months previous to the starting of the station, with the result that 10,000 cane seedlings were waiting to be planted out immediately on the acquisition of the land for the station.

(2) Within three years, over 150 cane varieties had been fully acclimatized, inclusive of a certain number of valuable importations from the other cane countries of the world. At the present date, the collections number 180 thick and 140 thin varieties, inclusive of over 80 importations from abroad.

(3) The raising of crossed seedlings, a difficult process as judged from the time and trouble taken in the other cane countries, was solved at Coimbatore within four years. In eight years, the work has reached a stage when the number of seedlings raised has to be limited to the space available at the station. That steady progress has been made is evidenced by the fact that in 1920–21 out of new seedlings raised 91,000 were examined. Of these, 8,000 were selected as being worthy of further study and 6,566 different varieties were analysed for their sugar content.

(4) Within six years, a sufficiency of suitable seedlings had been grown and preliminary tests made at the station to allow of a first distribution. This was made towards the beginning of 1918.

(5) The station has made substantial contributions to the extant literature on sugarcane, some of these breaking entirely new ground.

67. As this station is working to a great extent for Northern India, the ultimate judgment as to its utility must come largely from the farms there which test the Coimbatore productions side by side with the local varieties or other importations, of which there are a certain number in every Province. The first distributions were made only as late as 1918 and the Government farms take three to four years, fully to test the seedlings and distribute them to the growers in the districts. Below are given some of the results as reported from these farms.

68. At Gurudaspur, in the Punjab, a Coimbatore seedling, Co. 205, has given in weight of jaggery to the acre 33 per cent more than the best local cane. The local department has since extended its trial to four other district farms in consequence. At Tharsa, in the Central Provinces, half a dozen of the new Coimbatore varieties have proved superior to the best of the local kinds in net weight of jaggery obtained to the acre; the calculated extra net profit from two of them being about Rs. 200 to the acre. At the Central Farm, in Coimbatore, Co. 1, besides being distinctly superior to the best local cane in the quality of jaggery, has proved comparatively resistant to the attack of jackals, a point of some importance in the district. Similar results are being reported from the other farms, most of which are steadily increasing the area under the Coimbatore productions. At the present day, over 180 lots of selected seedlings are on trial in the various North India farms.

69. Besides the above, some of the importations from Overseas, though primarily intended to serve as parents in the cross-breeding work at the station, have been distributed to various localities and have been found useful, and are in demand for planting. Such are D. 74 at Peshawar, J. 33a in Mysore, and Fiji B at Nellikuppam. The station is in touch with 22 Oversea countries with the object of importing such varieties.

70. The work engaging the attention of the station at present is the breeding work described above, fresh parent canes and combinations of these being employed from year to year with the idea of steadily raising the standard of distributions. The requirements vary widely from Province to Province and a series of seedlings will have to be evolved to meet the different local conditions of soil and climate, times of planting and periods of growth. The Indian problem is more complicated than elsewhere, first because of the great extent of area involved resulting in wide variations as to needs, and, secondly, because of the bulk of the Indian area being outside the tropics, and the sugarcane is essentially a tropical plant.

71. The study of the different cane varieties is being continued, more attention being paid to what may be called the field physiology of the cane plant. The study

of the root-systems is receiving special attention at the present time.

(3) *Cotton.*

72. This section was started in 1920. Prior to this, much useful work was done in the district by the Circle officers. The present specialist on this subject, as Deputy Director of Agriculture in the Northern Circle, has produced improved strains of "Northerns" and "Westerns" which are now being largely cultivated in the areas where these types are grown. Similar work has in the past been done in the southern cotton tract where "Tinnevellies" are grown. The improved strain of "Northerns" was selling last season at over Rs. 50 a bale of 400 lb. above the ordinary price of cotton from this tract and it is estimated that there were over 30,000 acres last season grown with this strain. The improved type in the "Westerns" area last year sold at over Rs. 20 a bale of 400 lb. over the local market rate. Last year 12,000 acres were grown with this strain. In the "Tinnevellies" area, the greater part of the crop at the present day is the product of the strains raised by the Agricultural Department and their cultivation has once more placed "Tinnevellies" in the first rank of Indian cottons. The importance of this at the present time when Indian mills are endeavouring to spin higher counts cannot be over-estimated. In view of these results which showed what improvement was possible in the Madras cotton crop, it was felt that it was essential to place this work under a whole-time officer who could devote his entire attention, not only to improving existing varieties by selection, but also to studying the inheritance of both lint and habit characters by plant-breeding. The importance of this work was recognized by the Indian Cotton Committee and the necessity for such an appointment was emphasized by it. Much preliminary work has already been done. In the case of Cambodia cotton, the different types found in this crop have been separated. In the case of other cottons, various crosses have been made between different species of Indian cotton in order to study the inheritance of characters. Similar work has also been done by crossing Cambodia and Bourbon. A considerable amount of preliminary work has also been carried

out in devising simple and accurate methods for examining and ascertaining the value of different samples of seed cotton which will be of great assistance to Circle officers, who are also engaged in the improvement of the indigenous cottons by selection.

(4) *Millets.*

73. This officer was appointed very recently and so far his entire time has been taken up in a preliminary inquiry as to what lines of work are likely to produce results which will most quickly bring in a monetary return to the people for his services.

(iv) MYCOLOGY.

74. This section deals with diseases of the plant caused by fungi. The first essential in investigating such diseases is to grow the fungus on a suitable medium in order to ascertain how it lives and spreads and also to be able to identify it by the spores which it forms. In many cases, such a fungus has a definite resting stage by which the disease is carried over from one season to the next and thus infection is continued. It is also necessary to ascertain which particular part of the plant is attacked and how the fungus gains entrance into its host. All this means detailed microscopic work in the laboratory. The next step in dealing with the disease is to try different methods which are suggested by a study of the life-history for keeping it in check, or destroying it, and much work of great value to agriculture has already been achieved.

75. So little is known to the people about the causes of such diseases, which are usually attributed to "the evil eye" that a considerable amount of work in demonstrating methods of control has to be done before such treatment is likely to gain favour, and the more valuable therefore the produce of the crop, the more likely in the first instance is such a treatment to be adopted. Thus it is that in the case of many of the diseases which have so far been examined, these have dealt with what may be considered as crops of minor importance. The aggregate value, even in the case of these crops, however, of such treatment has been very great if it is reckoned in rupees. A notable example is the treatment of a

disease attacking arecanut gardens on the West Coast, which locally goes by the name of *Mahali*. The disease attacks the young fruit and spreads rapidly during the monsoon by means of spores spread by the wind and rain. The effect of the fungus is to cause many of the young fruit to drop and to arrest the development of the rest. If the attack is severe, a major portion of the crop is lost, while the quality of the balance is gr etly depreciated. The treatment in this case consists of spraying with a mixture of copper sulphate, lime, and resin. So successful has this treatment been not only in checking the spread of the disease, but also in destroying the spores which carry the disease from one year to the next that people have readily taken to this means of protecting their crops. The disease now is in many places very slight and can easily be kept in check on its first appearance. In 1916–17, nearly 43,000 palms belonging to 101 different garden owners were sprayed in this way, the work being done under the control of the ordinary district staff.

76. The disease known as "Mildew" on grapes has been dealt with in a very similar manner, both in Krishnagiri and in villages in the Madura district. In the latter place, last year 239 vines were sprayed at a cost of Rs. 89. As a result of this spraying, a good crop of grapes was produced worth Rs. 3,950. In the previous year, before any spraying was done, the crop obtained was only worth Rs. 710. Several of these garden owners have now arranged to purchase spraying machines for their own use.

77. Very successful work has been done in order to protect the cholam and tenai crops against a disease known as "Smut." Here, the disease is carried over from one year to the next by means of resting spores of the fungus which adhere to the seed which is to be sown. The treatment consists in steeping the seed for sowing in a solution of copper sulphate. The remedy was first demonstrated in the year 1914–15 when seed intended for sowing 1,300 acres was treated. This work has now been extended by the district staff, who sell the materials for steeping the seed to the villagers, and in the Ceded Districts alone in 1920–21 seed sufficient for sowing 47,450 acres was thus treated. It is difficult to estimate

what the value of such a treatment is, but at a moderate reckoning this cannot be less, and may be considerably more, than Rs. 3 per acre in a normal year.

78. Much work has been done for many years now in efforts to control a disease known as "Bud-rot." This attacks the leading bud of the palmyra and the coconut palm and was first investigated in 1906 in the Gōdāvari and Kistna districts. Here, it was found that very large numbers of palmyra trees were being annually destroyed by this fungus, and, though an individual tree in itself is not of very great value, when lakhs are killed, it means a very serious loss. When this disease spreads from the palmyra to the coconut, causing the death of the latter, the owner of such trees naturally suffers a still more serious loss and in such cases the preventive measures adopted for the control of the disease are welcomed. But such is not the case with the palmyra, and the operations for keeping this disease in check are not, and have not been, altogether popular. This unpopularity has been due rather to indifference and the objection to take the trouble to carry out the preventive measures because the value of the tree involved is so small, than to any other reasons. The preventive measures have been applied to the whole of the Kistna district which is now practically free from disease, but it is still present in the Gōdāvari and Guntūr districts, though to a very much less extent than was formerly the case. Owing to the high cost of controlling this work and the necessity for the appointment of a special staff, the Madras Agricultural Pests and Diseases Act, 1919, has been enforced for the last two years in order to obtain the co-operation of the people in undertaking preventive measures which have proved successful elsewhere.

79. Another fungus which may be cited is that causing "Bleeding disease" of coconut. The presence of this disease is shown by the exudation of a red viscous liquid oozing out from the stem of the tree. Its control consists in cutting out the affected part entirely, burning the wound thus made in order to check the flow of sap and then painting the cut surface of the wound with tar. In this way, the disease can be exterminated. It is common throughout all coconut areas of Madras, and especially bad in places where drainage is defective or the soil is alkaline.

80. A similar class of work has been done in the case of "red-rot" in sugarcane by introducing disease-resistant varieties. Methods of preventing the spread of disease have been worked out in the case of "blast" of paddy, "fruit-rot" of chillies, "leaf-rot" of ginger, "scab" of lemons and limes, "brown blight" of tea, "abnormal leaf fall" of rubber, etc.

81. A great deal more could have been done in putting into practice measures of control, had it not been for the ignorance of the people. The United Planters' Association of Southern India, who have realized what loss they suffer from plant diseases, have at their own expense appointed a Rubber Mycologist in order to investigate the diseases of this single crop alone. An appointment as Planting Mycologist has also been sanctioned to study the diseases of tea, coffee, cardamoms, pepper, and other planting produce, but the post has not yet been filled. The cost of this latter appointment is to be borne by the United Planters' Association of Southern India, supplemented by contributions from the Indian States concerned, the Administration of Coorg, and the Madras Government. With the spread of knowledge as to the damage done by such fungi, there is no doubt that in time full use will be made of the research which has been done in the past and which will be done in the future in this section.

(v) ENTOMOLOGY.

82. As in the case of fungus diseases, losses caused by insect pests require thorough investigation of the life and habits of the insect concerned before any method of control can be confidently advised. From the general knowledge of the habits of certain groups of insects, often, if information is given in time, stop-gap methods of saving a crop can be put into operation which, while not perfect, are good enough in an emergency. For a really satisfactory control of any particular insect pest, years of concentrated study are often necessary. Advanced countries like the United States of America realize this and men are detailed to study special problems and are not expected to carry on investigations into twenty different pests at once.

83. The habits and course of the life-history of the insect have to be investigated, and also its relations to its food plants and to its surroundings in general. For example, in the case of the Pink boll-worm referred to below, not only do the habits of the boll-worm itself call for study, as to how long it remains in this stage before attaining the resting or pupa stage, which will give rise to the parent moth, etc., but also those of the moth. How long can this moth live in nature? On what does it feed? Where does it lay its eggs? Are there any natural enemies which control it? These are some of the questions to which replies have to be found, and this catalogue is by no means an exhaustive list of the many riddles to be answered. Every factor likely to affect either the insect or the plant which it has chosen to attack has to be taken into account. This includes a study of agricultural methods just as much as a study of the insect, and it follows that, for all this, time is required.

84. In the case of human diseases, hundreds of years of experience and observation are at the disposal of those engaged in studying them. With plant diseases, at any rate, in India, very little of such experience exists, and nearly everything has to be started, as it were, from the beginning. A mass of information is now beginning to accumulate.

85. The preliminary survey of the South Indian Insect life has been published in that fascinating book of Mr. T. Bainbrigge Fletcher's entitled *Some South Indian Insects*. This book was published in 1914. Considerable advance has been made in our knowledge, especially of insects which have proved themselves pests of cultivated crops. The published proceedings of the third and fourth Entomological meetings at Pusa in 1919 and 1921 bring our knowledge of South Indian insects up to date. Recent work has been very largely confined to a close study of the life-histories of the chief crop pests, for it is only by working out the life-histories of these that means are suggested for keeping pests under control. Attention has been specially paid to the pests which attack our cereal crops.

86. Very detailed work is being done on the paddy stem-borer and careful records are being made with seasonal occurrences and habits. This work has been

carried out at a small sub-station in the Gōdāvari delta and considerable success has been attained by the adoption of the suggested methods of control. In the main, these consist of a careful examination of the seedlings when they are lifted from the seed-bed for transplanting and the destruction of any which show signs of having been attacked by the pest. The work involves a certain amount of trouble, but the attack is, so to speak, nipped in the bud before the pest can multiply, and a considerable reduction in the amount of damage done has been noticed. The universal adoption of such a method of control would beneficially affect the food supply of the country as the loss caused by this pest is said to amount to 10 per cent of the total rice crop of India. Several insect pests attacking cholam and cumbu have also been investigated and their life-histories worked out. Every year enormous loss is incurred on account of an insect known as the "mango hopper" which attacks the mango blossoms and prevents the fruit from setting. Successful methods of dealing with this which involve spraying when the tree is in bloom have been worked out, and by comparing such treated trees with others which have not been treated, it is estimated that much can be done to increase the mango crop by this method of control.

87. A successful method of dealing with the Rice hispa (a small beetle which causes very great damage to paddy nurseries and young rice crops) has been widely demonstrated on the West Coast and elsewhere by which this pest can be kept in control at very little trouble and expense.

88. One of the major lines of research in this section has been the detailed study of life-history and the amount of damage done by the pink bollworm, which is perhaps the most serious pest on cotton throughout the East. So serious is the damage done by this pest in other countries that special legislation has been introduced into Egypt in order to keep it under control, while France has passed stringent laws prohibiting the import of cotton seed into any of her colonies from places where this pest is known to occur. It has penetrated to the West Indies and the United States of America are spending large sums of money in an endeavour to keep it out of the cotton belt. In the Madras Presidency, the Madras Agricultural Pests and Diseases Act, 1919, has also

had to be enforced in order to check the amount of damage done by this pest. This line of control has been the total removal of the crop from the ground by a given date in order that there may be a period of sufficient length between the removal of one crop and the planting of the next when there are no cotton plants on the ground on which the grub or the moth can feed. The enforcement of such a legislation has naturally been unpopular. The time fixed when the crop should be uprooted has been up till now the 1st of August, by which time the bulk of the summer or second picking has been gathered. This inevitably caused a certain amount of hardship to individuals whose crops were backward or had been sown late in the season. But careful records maintained which show the seasonal incidence and increase of the bollworm, both in places where the Act has previously been enforced and in places where it has not yet been applied, indicate that the enforced measure has increased the value of the crop by at least 50 lakhs of rupees. Yet, the enforcement of this Act is a most unpopular measure for it is impossible to bring home to the people the fact that, if the Act were not enforced, this crop would be much more seriously damaged by the pink bollworm and its value would be greatly decreased.

89. The Entomological section has a great deal to contend with at the present time. The section certainly receives a very large number of reports of insect damage, but it is very seldom that such reports are received until the damage done is so great that nothing can be done to save the crop. It is very seldom indeed that the attention of this section is drawn to crop damage in the initial stages when it might have been possible to put into practice methods of control which would have saved the crop. Fortunately, there are signs of awakening interest and a better knowledge of the causes of the damage done; and it is to be hoped that in the future the work done in the past, and still being carried out, will bear fruit. On the West Coast, where perhaps the agricultural classes are better educated and possibly more observant than elsewhere, there is a considerable awakening of interest in the work of this section and it is not infrequent now for reports to be received from that part of the Presidency sufficiently early to enable

the staff of the section to reach the spot and deal with the pest in time to save the crop.

(vi) ENGINEERING.

90. This Department took over the work started by Sir Alfred Chatterton in connexion with well-boring and installation of oil engines and pumps for lifting water. The work was placed in charge of an officer styled "the Government Agricultural Engineer," and for several years very considerable progress was made in this direction. When the Department of Industries was reorganized in 1920, it was decided that this work, being largely mechanical engineering, should form part of the duties of that Department. This has freed the Government Agricultural Engineer for the much more important line of work in the direction of improving and designing implements suited to the agricultural conditions of South India and in order to give him every facility to work in collaboration with the agricultural officers of this Department, his head-quarters were transferred to the Agricultural College and Research Institute, Coimbatore. It has not, however, been possible for him to do much work in this direction up to the present since the workshops which he requires for carrying out this work have still to be constructed. He has been able to investigate the possibility of motor-tractors being applied to the South Indian agriculture and the general conclusion come to has been that the present types of tractors are not adapted to those conditions in Madras where they might otherwise have been usefully employed.

CHAPTER III.

LIVE-STOCK.

91. In 1911, a cattle survey was made of the Madras Presidency and an officer of the Agricultural Department was placed on special duty for this purpose for a period of six months. His report indicated to Government the necessity for the appointment of a special Live-stock officer who could devote his whole time to matters relating to animal husbandry.

92. This officer was appointed in 1916 and one of the first lines of work which he took up was the investigation of the Milk and Dairy Trade in the Madras City. As a result of this inquiry, it was found that it was impossible for Madras milkmen to supply pure milk at the then ruling price, and that the first step towards any improvement must entail an improvement in the economic condition of Madras milkmen. Practically, the only cows in Madras at that time which paid for their keep were those descended from Australian cows imported into Madras. It was recognized, however, that such animals entailed a considerable amount of risk as they were much more liable to succumb to cattle diseases than the indigeneous animals of the country, but in spite of this greater risk, the tendency among Madras dairymen was to breed from animals possessing this introduced blood and it was felt that the most satisfactory solution of this bankrupt industry was the importation of bulls of well-known milking breeds. With this end in view, four bulls of the Ayrshire breed were imported in 1920. At the same time, arrangements were made with the Military Dairy Farm at Bangalore to carry out some cross-breeding experiments between Ayrshire bulls and good milking cows of Indian breeds, from which the Madras Government could select the best male stock as breeding bulls. The introduction of Ayrshire bulls into Madras itself has proved a failure; but six cross-bred bulls from the Military Dairy Farm are now stationed in Madras for the service of milkmen's cows and all these animals are being well patronized by Madras milkmen for covering their cows.

93. In addition to this, three buffalo bulls are also stationed in Madras for service purposes. These animals are the best of a large number which were selected as calves, the selection being made taking into consideration the milking capacity of their dams.

94. In order to improve the economic condition of Madras milkmen themselves, a society of milkmen was started on a co-operative basis by the Live-stock officer in the latter part of 1919. Each of the members contributed a share of five rupees and, with this small capital, feeding stuffs were purchased at wholesale rates and supplied to each member at a slight profit. Within

twelve months, the profits made by this society amounted to over a thousand rupees. The society has now been registered as a co-operative society and is being worked by its own members under the guidance of the Registrar of Co-operative Societies. Help is being given by the Live-stock officer when this is required. It is hoped to be able to start several more societies on similar lines within Madras City.

95. Besides paying attention to the dairy branch of animal husbandry, a commencement has been made to improve the recognized breeds of Madras cattle. As there was evidence that the famous breed of Ongole cattle was deteriorating in quality, partly on account of the comparatively large export trade in breeding cattle to other cattle-raising countries, and partly on account of there being no organized attempt to maintain the quality of the Ongole breed by retaining the best stock in this country, work was commenced on this breed and a cattle-breeding station was opened at Chintaladevi in the Nellore district in 1918 with a view to raising up a pedigree herd of Ongole cattle. Already the nucleus of a breeding herd has been established and it is hoped that within the next three years a few good breeding bulls will be available for distribution. It is hoped also that, by careful mating and selection, it will be possible considerably to improve the milking capacities of this breed.

CHAPTER IV.

SERICULTURE.

96. There is another branch of entomology which deals with insects useful to man, and one of these important to Madras is the worm which produces silk. This is a branch of industrial entomology which involves a detailed knowledge not only of the insect but in providing its food and in the treatment of the cocoons for the reeling and subsequent treatment of silk fibre. As far as Madras is concerned, the silk industry is confined to the cooler parts of the Coimbatore and the Salem districts which are situated on the edge of the Mysore plateau. The industry, however, is of considerable industrial importance not only to the taluks where the silk worm is

reared, but also throughout the southern districts where the industry of silk weaving is a fine art. The value of the raw silk produced in Madras is estimated to be 30 lakhs of rupees a year which is only a small fraction of the final value of the cloths which are woven in the process of manufacture. Investigation showed that it was possible greatly to improve not only the yield but the quality of the silk produced. It was found that the silk-worm was badly diseased and was greatly weakened by in-breeding. A great loss of worms is incurred by the lack of any sanitary precautions taken in rearing and it was decided that this industry was well worth investigating. Accordingly, a Sericultural or Silk Expert has been appointed. The appointment for the time being is temporary for three years, but in view of the success already attained in improving the industry, there is every possibility of its being made permanent. Much improvement has already been made in the rearing of the worms. The Silk Expert travels from village to village and from house to house in order to point out the defects of the existing practice of rearing. Better methods of supplying fresh food and removing the remains of old leaves and excreta have been thoroughly demonstrated. So also has the necessity for rearing the worms in well-ventilated rooms instead of the crowded conditions under which heretofore they were reared. A station for the supply of invigorated seed from a higher elevation has been started at Coonoor and the seed supplied from this has been found to be much more vigorous and to produce a much better cocoon besides stronger seed than the locally raised seed. Steps have also been taken to supply seed which is free from the disease known as "pebrine." To do this entails a microscopic examination of all the seeds or eggs which are laid by each moth. Better methods of dealing with the silk waste from the cocoons and preparing it for the market, have been worked out and demonstrated which has resulted in considerable increase in the value of the crop to the rearer. The initial steps taken to improve this industry have been so successful that the opening of a silk farm in Kollegal mainly for the supply of reliable seed is under consideration, and it is hoped that funds will be available to start this next year.

CHAPTER V.

FRUITS, POTATOES, ETC.

97. For many years, there have existed a number of small stations upon and at the foot of the Nilgiris where tropical and temperate fruits have been grown on a small scale. These gardens have been under the charge of the Curator of the Government Botanic Gardens and Parks at Ootacamund. Besides these gardens, a station for the study of the potato crop, which is the main source of wealth to the Badagas of these hills, was opened in 1917. The importance of the economic side of this work and the possibilities for its development were realized by Government and it was decided to transfer the whole of it to the Agricultural Department. This was done in 1920. Valuable progress has already been made on the potato farm with the introduction of a large number of new varieties of potatoes many of which are likely to prove of great value in increasing the profits obtained from this crop. Several of these varieties have proved to be much heavier croppers than those which are now cultivated and it is hoped that some of them may prove more resistant to the diseases to which this crop is now subject, viz., "early blight" and "bangle" disease. So far, most of the work has consisted in propagating seed of these varieties so that they can be grown on a sufficiently large scale for obtaining definite information as to their yielding capacity. This has been necessary owing to the very heavy cost of importing seed in large quantities which would have been an unnecessary extravagance until it was proved whether any particular variety was found to thrive under the climatic conditions of the Nilgiris.

98. The cultivation of fruit on the Nilgiris is likely to receive a great impetus when the jam and pickle factory which is being constructed by the Department of Industries at Coonoor, is ready for work; and in view of this, a small fruit or pomological station was opened in 1920 at Coonoor. Here, besides testing new imported varieties of fruit such as peaches, Japanese plums, apricots, apples, pears and oranges, nurseries have been made where grafted trees of those varieties of fruits which have been found to do well are raised for sale to

the public. This opens up a large field for the development of fruit and the sales of such grafted trees which have already taken place indicate that there is likely to be in the future a large extension of this branch of work. In addition to this, much work has been done at the Kallar garden situated at the foot of the hills, where large numbers of tropical fruits are being propagated for sale to the public.

CHAPTER VI.

DISTRICT WORK.

99. The Presidency is divided into eight circles, each of which is in the charge of a Deputy Director of Agriculture. In addition to these eight circles, there are also a Deputy Director of Agriculture for Live-stock and a Deputy Director of Agriculture for Planting Districts. Where work is heavy, the Deputy Director is assisted by an Assistant Director of Agriculture, and each circle has its quota of upper and lower subordinate officers.

100. The work of the Deputy Director consists in experimenting at local agricultural stations with the staple crops of the locality and in seeing that any useful results obtained from these experiments are disseminated among the agricultural population. He keeps in touch with the work which is being carried out at the Research Institute at Coimbatore by the various experts there, and sees that any results of this research which have a bearing on improving the local agriculture are brought to the notice of the ryots through the medium of his district staff.

101. Very few people seem to realize what an agricultural station is, and there is much confusion between demonstration and experiment. The primary object of an agricultural station is experiment. It is the search for accurate information, which can only be obtained by comparison. The information sought for consists, for example, in finding out what plant food is required for particular crops, what are the cheapest ways of procuring manures which contain this, and bringing them within the reach of the ryot. It may consist in trying to improve the local varieties of crops by selection. This

implies selecting the seed from individual plants which appear to have the required characters, growing these separately and examining them to see whether their progeny are true to the parent plant, and comparing the progeny of one plant with that of others. All such work needs very careful cultivation and supervision. This means the multiplication of small plots and the greatest care has to be taken in harvesting the crop from each and every one of these which receives separate treatment or which is growing a different type of plant. Careful notes have to be kept on each plot grown to record the effect of manures on the growth of the plant or the habit of a particular strain, the damage done by insect pests or fungus diseases, etc. etc. These test plots have to be multiplied in order to eliminate natural variations in the soil and in order thus to obtain accurate comparison. Such work entails much greater expense in cultivation and supervision than is the case with ordinary straightforward field cropping, and thus it is that experimental work on agricultural stations does not necessarily pay for the actual cost involved in growing the crop. It can be seen, however, that the results of such experiments may be, and often are, of great value when these are applied to ordinary field cultivation, and the object of the Department is to get these results known to the farmers as quickly as possible. For this reason, each circle has its staff of what are termed agricultural demonstrators whose business it is to get into touch with the farmers in different places to put into practice what has been discovered. In this way, it is possible within a short time for a new method of manuring or a new strain of seed to be spread broadcast through a large tract of country.

102. Many people seem to consider that, after having discovered how to improve the yield of local crops, Government should acquire further areas of land in different places in the same tract and should, with the aid of the officers of the Agricultural Department, grow these crops on a large scale. Such work, however, can be done much more satisfactorily by enterprising farmers who are prepared to take the advice of the Department and, if such men show on their own lands that the advice of the Department means better crops and a better return for their expenditure, other more sceptical

farmers are much more ready to follow their lead than to copy methods which could be demonstrated on a Government demonstration farm. Further, such demonstration farms need officers to look after them and these can be much more usefully employed in helping farmers with their advice and guidance in adopting improvements.

103. As a concrete example of the work which agricultural stations can do, that which is being done in the case of cotton in the Bellary, Kurnool, and Tinnevelly districts, may be cited. The work of trying to improve the local varieties of cotton by selecting individual plants and examining the quality and quantity of the cotton produced by these commenced 16 years ago, and in no case did it take less than eight years' work before an improved type of cotton was produced. The work each year meant that the seed of individual plants had to be separately sown and each plant carefully examined. The cotton was picked from each plant and this again was examined in detail by the Circle officer. As the result of his examination, further plants were again selected and the seed of each sown in the same way. No one with the widest stretch of imagination would suggest that such crops could in themselves pay. But that they have brought in large incomes to the cotton growers in those districts is certain. At present, the major portion of the cotton in the Tinnevelly district traces its origin to a single plant and in the Bellary and Kurnool districts, there are very large areas which are grown with seed of similar origin. The Tinnevelly cotton is now in great demand not only in Madras but in Bombay and abroad for spinning finer counts of yarn. There is a keen competition to get it and this competition has greatly increased the price paid to the ryot for this crop. It was estimated that in 1918 this single improvement had increased the income of the cotton growers of Tinnevelly, Madura, and Rāmnād by Rs. 50,00,000 *per annum*. The whole expenditure on the Department from 1906–07 till that date amounted only to just over Rs. 40,00,000. The same thing is beginning both in Bellary and in Kurnool. Last year, in Kurnool there were 30,000 acres grown with such an improved strain of cotton and the produce sold at over Rs. 50 a bale above the ordinary market rate. In Bellary district,

there were 12,000 acres of such an improved strain of cotton and the produce sold at Rs. 20 a bale over the ruling market rate. If this work of demonstrating the increased value of these crops had been confined to Government "demonstration farms" instead of this improvement being taken direct to the ryots, no such results could have been achieved.

104. In the following description of district work, each circle is taken categorically and an attempt is made to describe the work which is being done in each of them, though only the main features and the most important items can be dealt with.

First Circle.

105. The first circle comprises the five northern taluks of the Kistna district, viz., Yernagudem, Tanuku, Narasapur, Bhimavaram and Ellore, and the Gōdāvari, Vizagapatam, and Ganjām districts. It is in the charge of a Deputy Director with head-quarters at Cocanada assisted by a district staff of eleven demonstrators, and three demonstration coolies. There are two Government farms, one at Samalkota in the Gōdāvari district and one at Anakapalle in the Vizagapatam district, with farm managers and assistant farm managers.

106. After the construction of the great anicut across the Gōdāvari river completed in the early part of 1852, the abundant water supply completely changed the methods of cultivation. Gingelly, ragi, and horse gram were replaced by sugarcane and paddy and the ryot population began to enjoy an unprecedented period of prosperity. During the years 1860 to 1896, the cultivation of sugar-cane was extended and it brought in large profits. By 1896, this cultivation had reached its zenith and thousands of tons of jaggery were exported from Cocanada to Bombay, Calcutta, and the European markets.

107. In 1897, however, there came a set back in the form of a serious fungus disease known as "red-rot." This attacked the local canes over a large area and from 1897 to 1900 it ravaged the district and threatened to exterminate the crop. At this stage, the attention of the Government was called to the grave situation by the Cocanada Chamber of Commerce. The Government Botanist was deputed to make an investigation,

and in his report in 1901 he suggested the establishment of a station at Samalkota to study the disease and discover its remedies. In 1902, twelve acres of land were rented for this purpose, and in 1905 the Government acquired the site of the present farm.

108. The main lines of work at this farm for the first few years were the testing of new varieties of canes, new methods of cultivation, and the use of manures.

109. It was soon found that a variety of cane known as Red Mauritius not only gave a yield of 50 tons of cane and over $4\frac{1}{2}$ tons of jaggery per acre but was resistant to a large extent to the "red-rot" fungus, and setts of this cane were distributed to the ryots. Improved methods of cultivation were introduced at the same time, such as planting in lines to facilitate inter-cultivation, reduction of seed-rate, and irrigation, and thorough drainage by means of trenches which reduced the attack of the fungus.

110. By 1906, the preliminary purpose for which the farm had been started was accomplished. Canes of all available varieties had been collected and tested and their value as regards disease-resistance and yield determined, and the best were multiplied and the setts distributed to the ryots. The situation had been saved, the confidence of the agricultural population gained, and the area under sugarcane cultivation once more increased rapidly.

111. During the years 1905 to 1921, on the average nearly a quarter million setts a year of different kinds of cane were distributed to the ryots and these improved varieties are now under cultivation in the district to the almost entire exclusion of the old local canes so prone to the attack of fungus.

112. Planting in lines instead of pits reduces the seed-rate from 30,000 to 15,000 setts per acre, a saving, with setts at Rs. 3 per thousand, of Rs. 45 per acre. Lack of drainage predisposes the canes to attack by "red-rot" and if drains are dug between every double line, this danger is largely avoided.

113. With regard to manures, the substitution of fish guano for castor-cake is an improvement which is being taken up by the ryots on the advice of the

Department and at the present prices ruling for castor-cake, this results in a decided saving.

114. Improved methods of making jaggery have also been demonstrated.

115. Having solved the problem of the sugarcane crop, the Agricultural Department next turned its attention to paddy and green manures. Pure strains of paddy varieties raised from single plants selected for heavy yield were grown and compared at the farm and *Rasangi* No. 3 was introduced in the Amalapuram taluk in 1920 and cultivated over an area of 50 acres. Last year, it was cultivated as a main crop over 1,000 acres. In Ramachandrapuram and Cocanada taluks, this strain and another called *Konamani* No. 3 have become popular and last year six per cent of the paddy grown in these two taluks was grown from pure seed distributed primarily from the farm.

116. The practice of economic planting is gradually spreading as a result of the teaching of the Department, and in 1915, 8,305 acres in the Ramachandrapuram taluk alone were under this improved method which reduced the seed rate by 50 per cent. This results in a saving of at least Rs. 3 per acre, and since in this and the Cocanada taluks alone, there are over two lakhs of acres of paddy, the improvement will result in a saving of six lakhs of rupees.

117. An effort is being made to substitute an early variety of paddy for the main crop in the delta followed by a long duration paddy. For this purpose, two varieties introduced from Tanjore and Nellore are showing promise. If successful, this will enable two crops of paddy to be taken when there is a good supply of water in the canals. At present, the planting of the second crop is deferred till February for fear of the crop being destroyed by the cold winds of the North-East Monsoon, with the result that the crop suffers for want of water in April. This is a line of future work of the Department in the Gōdāvari district.

118. In 1919, the use of bone meal and fish guano was advocated by demonstrators and dhaincha seed for raising green manure crops was introduced in the same year into the Amalapuram taluk. This soon became

popular and is now being sold by local merchants in preference to the local green manuring seeds, sunn-hemp and tigapesalu. In 1921, this crop was being grown over 5,000 acres where a few years before it was unknown.

119. The development of agricultural co-operative societies for the purchase of manures and seeds is receiving attention. This is especially necessary to protect the ryots from unscrupulous merchants who are beginning to make their appearance. Some of these dealers buy inferior and adulterated manures and sell them under such names as "special paddy mixture" and "sugarcane fertilizers." Chemical analyses show that these mixtures are not what they are represented to be and contain a large quantity of material which is of no manurial value whatsoever. The ryot is attracted by the low price, but he does not get full value for his money. It is this tendency on the part of merchants to exploit a flourishing agricultural district which the Department wishes to control when it advocates the passing of a Fertilizer Act.

120. Early in the present century, a fungus disease known as "bud-rot" made its appearance on the palmyra palms. It is believed to have started on an island in the Gōdāvari river and it spread rapidly in both the Gōdāvari and Kistna districts. This disease was investigated in 1905 by the Imperial Mycologist and, as a remedial measure, the cutting out and burning of the tops of all diseased trees was suggested. The methods of dealing with this disease have been modified from time to time in the light of the experience gained and the control measures have now developed into a big campaign carried out by a Tahsildar, two Deputy Tahsildars, and 18 Revenue Inspectors, aided by additional staff during some months in the year.

121. The Madras Agricultural Pests and Diseases Act was put into force to deal with this disease in 1920, and the work entrusted to a Special Deputy Collector. Propaganda work is carried out by means of posters, lantern lectures, leaflets, etc. The result of this campaign has been that the number of trees which have died during the six years 1913—18 in the Kistna district is only the death-rate for the three years before 1913; while in the Gōdāvari district, the death-rate has been

reduced by two-thirds. 123,273 principal new centres of infection have been removed and 91,756 internal centres of infection, which would soon have spread, have been operated upon. Over 200,000 of infected centres have thus been saved from death and infection. The cost of treatment is only six pies per tree. During the last three years, no serious new outbreak of the disease has occurred.

122. The old *Vizagapatam district* (including the portion transferred to the Agency division) covers an area of 17,222 square miles and nine-tenths of it are zamindari land. Here, single planting of paddy results in a saving of seed-rate and labour to the extent of Rs. 2–12–0 per acre. This and the improvement of the sugarcane crop is amply demonstrated on the Government farm, with the result that the ryots have already been saved an unnecessary expenditure of over a lakh of rupees.

123. Agricultural implements in this district are primitive and the use of more up-to-date and economical tools is being taught. By using a harrow to loosen the surface soil, for instance, two or three acres can be worked in a day at a cost of seven annas an acre, whereas the local method of hoeing is a lengthy process and requires anything from three to ten coolies an acre depending on the crop. With wages at four annas a day, this amounts on an average to Rs. 1–2–0 per acre. A manure, seed, and implement depot is maintained at the Anakapalle farm, where ryots can obtain these materials at cost price. 10½ tons of green manure seed and 24 tons of cane setts have been distributed from this farm. Also, 30 improved mhote buckets and 40 improved ploughs have been sold.

124. Along the foot of the Eastern Ghats, the mango tree is cultivated on a large scale and the art of grafting has been practised for generations. The fruit of these trees commands a high price on the Calcutta market and the produce from the gardens is valued at a large figure. During recent years, an insect pest known as the "mango hopper" has been discovered as an enemy to this crop which makes its appearance at the flowering season and does a considerable amount of damage in checking the setting of the fruit. A remedy has been found by the

Government Entomologist in spraying with fish-oil soap and this has been largely adopted.

125. In the other districts in this Circle, the work of the Department has been hampered by want of staff and in the *Kistna and Ganjām districts*, it has not been possible to do anything till quite recently. New varieties of paddy and sugarcane suited to local conditions and improved methods of cultivation are now being introduced by demonstrators and the use of manures taught.

126. Future progress in this large Circle depends upon staff and, with the present staff available, the Department has reached the limit of its capabilities. Large areas yet remain to be conquered and there is a big field open for the introduction of new strains, new methods of cultivation, and co-operative systems of obtaining supplies of seed, manure, and implements, all resulting in a direct saving of money to the cultivator.

Second Circle.

127. The second Circle comprises the southern taluks of Kistna, Guntūr, and Nellore districts. It is in the charge of a Deputy Director with head-quarters at Guntūr. It is only recently that the Department has been able to take up work here. The area represented is about $12\frac{1}{2}$ * million acres, of which about 5 * million are cultivated. On the Divi Island at the mouth of the Kistna river, there is a big pumping project which irrigates 40,000 acres. The work of the Department at present is being concentrated on the Nellore district as being the most agriculturally backward, and three demonstrators are at work in this area. A dry-land farm has been opened shortly at Guntūr. Soil surveys of the Guntūr and Kistna deltas have been made and published, and an important part of the future work of the Department in this locality will be to study the manuring problem based on these surveys. A beginning has been made by introducing the use of fish manure for paddy to ryots, and already some satisfactory results have been obtained. Work in this area is all new and has no past history : in fact, it is, so to speak, in the advanced firing line.

* The figures include the area of the northern taluks of Kistna also which are situated in the first circle.

Third Circle.

128. The third Circle comprises the Bellary, Kurnool, Cuddapah, and Anantapur districts, and so far the work of the Department has been confined to the first two, while the last two have not as yet been touched owing to want of staff. The establishment of this Circle consists of a Deputy Director with head-quarters at Bellary, an Assistant Director, and six demonstrators, as well as the staff of four farms. The farms are situated at Hagari, Bantanahal, Nandyal and Sirvel.

129. In the *Bellary district*, over two million acres are under cultivation. Of these, 59,000 are under irrigation, 32,000 being devoted to paddy, and 7,300 to sugarcane. On the dry lands, cotton, jonna, and korra are the most important crops. The holdings average 25 to 30 acres each, and cultivation is usually carried on by the owner under the ryotwari system.

130. The most important line of work taken up by the Department has been the improvement by selection of the local cotton. A strain known as H. 25 has been evolved on the Hagari farm and seed distributed to the ryots in large quantities. This strain is so much superior to the locally grown cotton that the lint fetches a premium of Rs. 20 per bale of 400 lb. over the local market rate, and in a normal year a gain of at least Rs. 2-8-0 per acre is obtained. Last year, 12,000 acres were sown with this strain. There are 450,000 acres under cotton cultivated in the district so that the possibilities of profit to the ryot derived from this particular piece of work achieved by the Department are very large.

131. In addition to this, a campaign has been carried out to combat the disease known as "smut" on jonna, the use of concentrated manures like fish guano and bone-meal has been popularized, monsoon ploughs sold, and the advantages of the single-planting of paddy, and the use of green manures demonstrated. Improved methods of jaggery-makinghave also been demonstrated at Hospet and new varieties of sugarcane introduced.

132. In the *Kurnool district*, about two million acres are under cultivation. Of these, 109,000 acres are irrigated, 43,000 acres being devoted to paddy. On the

dry lands, cotton, jonna, korra, and arika are grown. The average holding is about 20 acres.

133. An improved strain of cotton known as N. 14 was evolved on the Nandyal farm, and the seed has been distributed in large quantities. Last year, 300,000 acres were sown with this, and the total calculated gain, as compared with the local variety, was Rs. 31,000. The season was a poor one, however, due to lack of rain, and in a normal year the gain would have been not less than two lakhs of rupees. Here, again, the possibilities are immense as 300,000 acres are under cotton cultivation in the district.

134. The campaign against "smut" on jonna is another feature of the work of the Department in this district. It has been found that this disease of cholam can be entirely checked by soaking the seed before it is sown in a solution of copper sulphate. As a result of propaganda on the part of the Department, 47,450 acres were sown with treated seed and the result has meant a saving to the ryot of at least of Rs. 1 8–0 per acre, or a total of over Rs. 71,000.

135. The use of concentrated manures for paddy results in a profit of about Rs. 10 per acre and if the total area under paddy in the Circle were manured on the lines advised by the Department, the gain would be over 37 lakhs of rupees.

136. At the Bantanahal farm, considerable success has been attained in improving the local breed of sheep, both as regards the quantity and quality of the wool, and the quality of the mutton. This farm has, however, now been closed and the work transferred to the station at Hagari.

137. The difficulty which lies in the way of spreading the knowledge of improvements is the illiteracy and conservatism of the ryots, but it will be seen from the above that, were the recommendations of the Department as regards these three improvements carried out on every possible acre in these two districts alone, the monetary gain would be over 86 lakhs of rupees.

138. Future lines of work of the Department in this Circle are, in addition to those just described, the development of seed unions and farms, the increase of

the percentage of lint to seed in cotton *kapas*, the co-operative ginning of *kapas* and sale of lint, and the distribution of improved types of jonna and ragi seed which have already been evolved at the farms. Also, there is the need to find a remedy for a disease known as "sugary disease" of jonna for which the co-operation of the experts at Coimbatore is required.

FOURTH CIRCLE.

139. The fourth Circle consists of North Arcot and South Arcot, Chingleput, and Chittoor districts, and contains an experimental farm at Palur in South Arcot and a demonstration farm at Gudiyattam in North Arcot. It is a very large Circle comprising an area of 17,843 square miles and the staff consists of a Deputy Director with head-quarters at St. Thomas's Mount, an Assistant Director, two farm managers with two assistants, and seven demonstrators. With this small staff, some of whom have only recently been appointed, much really necessary work in this large area must needs be left untouched. More than three-quarters of the population are employed in agriculture and the individual holdings are quite small—three or four acres—often farmed by tenant cultivators on varam tenure.

140. In order to give as wide a publicity as possible to improved methods of agriculture advocated by the Department, a new idea has been tried, viz., private demonstration farms in the neighbourhood of the head-quarters of each demonstrator. The co-operation of interested ryots and landlords is sought and a portion of their lands is selected, and on these new strains and varieties of crops are grown and improved methods of cultivation are carried out side by side with local varieties and methods. The landowner provides the necessary labour, seed, manure, etc., and all the operations are carried out under the guidance and observation of the Department's demonstrator, and a regular profit and loss account is kept. Thus, the ryots are able to see for themselves the advantage which accrues from the improved strains and methods, as compared with their own method.

141. Sugarcane is an important crop in the *South Arcot district*, but the local cane grown was soft and

became so attacked by diseases and pests that by 1908 the industry had fallen to 180 acres in the Cuddalore taluk. When the Department began operations in 1905, it set to work on the Palur farm to revive this important industry. New varieties were tried and it was soon found that several were suited to the district. These were distributed to the ryots as rapidly as setts could be produced. Messrs. Parry & Co.'s factory at Nellikuppam greatly facilitated the work and by 1909 there were 875 acres under new varieties. In the following year, 30,000 setts were distributed from the farm, and there are now 4,000 acres under cultivation in the Cuddalore and adjoining taluks. This is an example of the use of a Government farm, the work done at Palur being responsible for this revival of an old and important industry. The Cane-breeding Station at Coimbatore of course co-operates, new canes produced there being tried at Palur, which is a link in the chain leading from the expert at head-quarters to the ryot in the field. At the present time, in order to facilitate the rapid introduction of new and improved varieties of canes, setts are given out to the growers at reduced prices on condition that they return double the number of setts given to them at the same rate at which they purchased them. Setts thus purchased are distributed to other ryots.

142. In the preparation of jaggery, the fuel problem is one of great importance. The Department has lately introduced an improved furnace which saves 50 per cent of fuel, representing a profit of Rs. 50 per acre. Forty furnaces are now at work in the Circle. The average yield of the improved varieties introduced by the Department is 65 lb. of jaggery for each boiling, which is 12 lb. better than the local canes. Taking the produce of an acre as 100 boilings, the difference in favour of the new varieties is 1,200 lb. of jaggery, or an extra profit of Rs. 156 per acre at the present market rate of Rs. 65 for 500 lb. of jaggery.

143. Groundnut is another important crop in this Circle, and as a result of the experiments carried out at the Government farm, it has been found that it is more profitable for the ryot to grow a mixture of this crop with a cereal like cumbu, ragi, or tenai, than to raise these crops in rotation.

144. In taluks where demonstrators are at work, the single-planting of paddy is gradually being adopted by ryots with, in consequence, a reduction in the seed-rate and a saving of food to the country. This improvement is encouraged also through the medium of leaflets and calendars. It can be safely stated that ryots who in the past have been using 40 to 50 Madras measures per acre have reduced the seed-rate by at least 50 per cent. Single-planting was introduced into the Kallakurchi taluk in 1910, where the usual seed-rate was 40 to 50 Madras measures per acre. As a result, it is now 8 to 15 measures only. Supposing there is a saving of only 20 Madras measures per acre, the result is practically ten million Madras measures of paddy added to the food supply, which, at current market rates, represents a saving of nearly 13 lakhs each year in the fourth Circle alone.

145. The ryots of this Circle used at one time to depend on the local forests for a supply of leaves for their paddy fields and much resented the restriction in the supply from these. The Department has steadily taught them the use of green dressings raised on the land to replace these leaves. This has been up-hill work; for local prejudice is hard to overcome; but seed has been annually distributed and the practice demonstrated, with the result that the Kallakurchi taluk is now not only self-supporting as regards the supply of dhaincha seed, but is able to supply other taluks. The cost of three cart-loads of forest leaves, the quantity usually applied to an acre of paddy, is Rs. 10—12. To produce the same quantity of organic matter by raising a green manure crop costs only Rs. 2—3. Not only is labour and trouble saved, but there is a gain of Rs. 8 per acre. In the last ten years in this Circle, nearly 20,000 acres of green manure crops have been actually grown by the farmers themselves, which has meant a benefit to them of some Rs. 1,60,000. It can be imagined how great such benefit would be if the practice were universal.

146. Other lines of work done by the Department are the introduction of fish guano and castor-cake as manures. To popularize these manures, the Department has purchased them whole-sale, retailing them to the ryots in small quantities. 168,000 lb. of fish guano and 50,000 lb. of cake have been distributed in this way,

spread over as many villages as possible, with the consequence that the demand has rapidly increased. The supply has now been left to private enterprise.

147. Improved monsoon ploughs have been introduced and improved methods of collecting and storing farmyard manure taught and demonstrated.

148. Future development depends upon the increase of staff in demonstrators and includes the introduction of better varieties of paddy, the control of diseases and the introduction of the improvements indicated above into fresh areas.

Fifth Circle.

149. The fifth Circle comprises the Tanjore and Trichinopoly districts, an area of 9,226 square miles. The staff consists of a Deputy Director and an Assistant Director with head-quarters at Trichinopoly, with four demonstrators and five assistant demonstrators.

150. The *Trichinopoly district* is one of the hottest and driest in the Presidency. The chief food crops are paddy, cumbu, cholam, varagu and ragi. The main industrial crop is cotton, while the oil-seeds consist of groundnut and gingelly. Plantains hold an important position along the banks of the Cauvery. The average size of holdings of wet lands is about five acres and the majority of ryots farm their own lands. This makes it much easier to effect improvements than where land is held by tenants on an annual lease.

151. When the Department first began work in this district, its first aim was to improve the paddy crop and the main difficulty encountered has been the want of a farm on which to try new varieties and discover which were best suited to local conditions. A strain known as No. 24 selected by the Government Economic Botanist at the Paddy-breeding Station at Coimbatore has become popular. Last year, 200 Madras measures of seed were distributed and the year before, 144 measures. The increase of crop from this strain averages 400 lb. or Rs. 25 per acre. It ripens evenly and is drought-resistant and so is of special value when water is scarce. The area under this variety is spreading rapidly.

152. Cambodia cotton seed to the amount of 25,000 lb. was sold last year, sufficient to sow some 1,000 acres at

least, and this gave an increased yield of 5 to 7 per cent of *kapas* over the crop raised from seed locally available. With the increased price for better quality, this represents an increased profit of Rs. 10 per acre, amounting to Rs. 10,000 increase in profit to the growers. The Pest Act, under which the land must be clear of cotton for two months, has been in force for the last two seasons, and as a result the damage caused by the pink boll-worm, one of the most destructive pests of cotton, has been very considerably decreased.

153. Two improved varieties of sugarcane have been introduced and these yield better than local varieties by 20 to 40 per cent.

154. Improved methods of making and storing farm-yard manure have been demonstrated and taught, and the use of green manures introduced: these are now extensively grown in the district. Oil-cakes are largely used as manure and fish-guano has also been introduced. Over 50 tons of this were sold from the departmental manure depots last year. The Department has had prepared a special manure mixture for the Tanjore delta, consisting of fish, oil-cake, bone-meal, and mineral phosphate in suitable proportions. In the Cauvery valley of this district last year, 1,000 bags, sufficient to manure 500 acres, were disposed of from depots. Improved implements are also available for sale.

155. As a direct result of these operations, the following results have been achieved by the Department. On an average, 700 acres have been sown during the last three years with green manure seed sold by the Department resulting in an increase of not less than Rs. 8 per acre. In addition to this, there are large areas now where green manure crops are regularly grown by the ryots. This practice is the result of the work of the agricultural demonstrator. By using a candy of groundnut cake as a manure for paddy, an increase of about 500 lb. an acre is obtained, leaving a profit of Rs. 7 per acre. As there are 348,000 acres of paddy in Trichinopoly, there is here a possibility of adding some 24 lakhs of rupees to the agricultural wealth of the district were the recommendations of the Department fully followed. In addition to this, variety No. 24 paddy gives an increase of

300—500 lb. of crop per acre, which at current rates adds a profit of Rs. 18 to Rs. 30 per acre.

156. Let us now turn to the *Tanjore district*, and note the progress made by the Department. Here, the delta of the Cauvery occupies more than half the area of 3,727 square miles, a great level stretch of over a million acres of paddy, fields interspersed with topes of mango, *iluppai*, coconut, and other trees.

157. Ten years ago, a Government farm was established at Manganallūr, near Māyavaram, in order to study on the spot the agricultural needs of the delta. The soil survey of this delta made by the Government Agricultural Chemist, Coimbatore, showed that over very large areas phosphates were needed as a manure and one of the main problems here has been to find out how these can be most profitably applied. To give some idea of what manure alone will accomplish when properly used and continuously applied, the following results obtained on the farm are summarized :

Manure.	Rate per acre.	Number of years app'ied.	Average profit per acre per annum.		
			RS.	A.	P.
Bone super	100 lb.	3	12	12	6
Green leaf	2,000 ,,	6	15	15	3
Bone super	120 ,,				
Bone-meal	82 ,,	4	5	5	5
Flour phosphate	82 ,,	3	7	13	7
Manure mixture	300 ,,	2	15	2	8

158. When one realizes that not one-third of the total area of this delta receives any manure at all from one year to the next, it is at once evident what a huge scope there is, not only in the way of profit to the grower, but of increase in the food supply of the country. If we take Rs. 5 only as the average extra profit which could be obtained from about 60 per cent of the area of this delta, the value of the increased produce would amount to at least 30 lakhs of rupees per annum. A huge trade in manure would be created which would more than absorb the total quantity of the bone-meal and fish manure now exported, and their value as a manure would not then be lost to the country. Its results achieved such as these, which have made the Agricultural

Department of Madras advocate that the export of these manurial substances should be prohibited and that they should be kept in the country for the benefit of the cultivator and not exploited for the benefit of traders and cultivators of foreign countries.

159. Much has been learned at this agricultural station regarding the cultivation of heavy delta soils and it is now much easier to realize the difficulties which the farmers of the delta have to contend with in the matter of irrigation and water supply. It has been definitely proved that the use of green leaf manure on these heavy soils cannot be adopted without caution. It is only when conditions are extremely favourable that these can be safely used, except in the case of lands which are accustomed to receive heavy applications of cattle manure. On the other hand, it has indicated that any work which the Department can do in popularizing the use of green manure crops must be confined to the lighter soils which do not crack in the dry weather. It has thus been possible to concentrate and to popularize the cultivation of green manure crops in special areas such as the Shiyali taluk and parts of the Māyavaram taluk as well as in other places where soil conditions admit of these crops being grown and ploughed in as manure. This work has created a regular industry in the Vedaranniyam tract of the Tiruturaipundi taluk, and here large quantities of wild indigo (Kolingi) seeds are now collected each year for sale on the delta. This year the output of this tract was 1,800 bags valued at Rs. 6 a bag, yielding an income of Rs. 10,000. Co-operative societies, merchants, and private individuals can now buy seed direct from this tract, so that the trade is established and the Department can gracefully retire from it. This year it is estimated that 1,000 bags will be used by the delta ryots, sufficient for an area of 12,500 acres. The average increase obtained by growing green manure crops on the Government experimental farm is estimated at 4 kalams. At Rs. 3 per kalam, this means Rs. 12 per acre. But taking it at 2 kalams an acre, over the whole 12,500 acres sown this will amount to Rs. 75,000, or just about one and a half times the cost of the Department in the fifth Circle. Not only so, but the plant seeds and sows itself so that once it gets a good stand it produces seed in sufficient quantity to give a

fresh stand the following year and the effect is cumulative.

160. Attention has been devoted to improved strains of paddy, and the strain of *Red Samba* No. 76, selected on the farm by the Government Economic Botanist has shown itself superior by 16 per cent to the local *Red Samba* in yield, and this strain has now been introduced on 6,500 acres in the delta and yields a profit of Rs. 78,000.

161. A paddy-breeding station is being established at Aduturai to meet the needs of the Cauvery delta by producing improved strains of paddy.

162. Future lines of work will be the growing of improved strains of paddy on seed farms and distributing them, impressing on the ryots the value of manures, especially farm yard manure and bones, which should be more carefully conserved, and the value of co-operative organization. It is difficult to persuade the man who holds 50 to 100 acres of wet land to whom improvements should appeal, to try anything new, and the small man cannot afford to do so. There is also the bugbear of the lazy and indifferent landowner who does not realize that it is a patriotic duty to raise as much as possible from that portion of his native land which it is his privilege to hold, but these difficulties are being steadily overcome by the district staff.

Sixth Circle.

163. The sixth Circle consists of Madura, Rāmnād, and Tinnevelly districts covering an area of over 14,000 square miles. The staff consists of a Deputy Director with head-quarters at Madura, an Assistant Director, and nine demonstrators, each of the latter in charge of a sub-circle. In addition, there is the farm staff at the Koilpatti agricultural station.

164. The main object of the Department when work was first taken up in the Tinnevelly and Rāmnād districts was the improvement of Tinnevelly cotton, coupled with the general improvement of the agricultural practices obtaining in the black cotton soils. These aims have been kept well to the fore and excellent results have been obtained. Karunganni, the original "Tinny" cotton, had gradually lost its special reputation, since it was badly

mixed with the Uppam cotton introduced after the famines of the last century from the Coimbatore district. Uppam has a short, harsh staple, and Karunganni is much finer, longer, and stronger. Karunganni, the real "Tinny" cotton, had to be isolated from this mixture and then improved by careful selection. It takes at least eight years to perfect a new strain of cotton and bring it to the stage at which the seed can be distributed to the cultivators. In 1913, two new strains known as Company No. 2 and Company No. 3 were perfected on the agricultural station at Koilpatti and seed was distributed to the ryots of these districts. The cotton was tested by the spinning mills which extolled its high spinning quality. Not only was the quality improved, but the ginning percentage was considerably raised. One of these strains gives 29 to 30 per cent and the other 31 to 33 per cent of lint to seed cotton, while the ordinary cotton of the district gives only 25 per cent. These good qualities were quickly appreciated both by the ryots and the purchasing firms. When these strains were first cultivated on any scale, there was keen competition among the firms to obtain this lint, some of them paying as high as Rs. 20 a bale over the price of the ordinary cotton. This impetus made the spread of cultivation of these strains an easy matter, the only difficulty being to reserve as much seed as possible for sowing. The Department entered into contracts with the ryots in many villages to grow this cotton seed for them under special conditions and they provided large quantities of seed, but so big was the demand that it was not possible to meet it entirely with the men and money at the disposal of the Department. Within two years, almost the whole of the cotton of this tract was either a pure crop of these strains, or a mixture containing the seed of these strains in a large proportion. The result of this has been that the price of Tinnevelly cotton has risen greatly when compared to the price of cottons from other parts of India; and this has meant a very considerable income to the ryots of these districts which in 1918 was estimated to be as much as 50 lakhs of rupees per annum. To meet the large demand of this improved seed, ryots who were known to have raised pure crops from it were induced to sell their cotton direct to the firms and reserve their seed for sowing. Often several

ryots would bulk their cotton together in order to have it ginned in this way.

165. This system worked well for some time, but it was soon found that provision must be made to insure that all the seed stocked by co-operative ginners was used for sowing purposes and not for cattle food. To insure this, many of the ryots who sold their cotton co-operatively were induced to pool their seed until the next sowing season, and then sell it co-operatively. Such organizations are called seed unions, and at present about a dozen are in existence. Thus, the improved strains, "Company cottons" as they are called, have spread rapidly, and by 1917 some 56,000 acres were sown with them, while, in 1918, it was estimated that at least 75 per cent of the cotton crop from Sattur southwards, and 50 per cent between Sattur and Virudupatti, was derived from seed distributed by the Department. In subsequent years, it was found impossible to keep track of the area under "Company seed," the work of distribution having been largely taken up by seed unions. These strains have worked their way northwards to Coimbatore, and during the present season over 39,500 lb. of seed were supplied by two seed unions to this district over and above local demands.

166. A cotton which is largely cultivated in Central India had somehow found its way down to Tinnevelly. From the resemblance this plant bore to the crop known as "Pulichai" (*Hibiscus cannabinus*), it was named "Pulichai cotton." This species gives a very short, harsh lint, and by 1914 its introduction was threatening to reduce the value of Tinnevelly cotton to the same low level as the cottons of Khandesh and the Central Provinces. By close co-operation between the Agricultural Department, the buying firms, and the growers themselves, it was possible to stamp this cotton out entirely within a period of three years. This work was greatly assisted, in fact rendered possible, by the introduction of the "Company cottons" produced at the Koilpatti farm. Recently, a few ryots have been attempting to grow this cotton again with the intention of its being used to adulterate Tinnevelly cotton, and hoping thereby to sell their produce at the price ruling for the latter. The district officers of the Department have still to keep a

constant watch to see that this cotton does not gain the upper hand.

167. The sowing of cotton and cumbu with the seed drill, a practice unknown in the south, was introduced by the Department, and the area under this method of sowing has increased year by year till it had reached 19,200 acres three years ago. As a proof that this improved method of agriculture has established itself in the Circle is the fact that over 650 sets of drilling implements have been sold to ryots at Rs. 11 to 18 per set and, in addition, there are drilling implements at work made by the ryots themselves. The merits of "Disc" ploughs, "Monsoon" ploughs, and "Vitis" ploughs, have been demonstrated by the Department, and 141 have been sold in recent years. Many more would undoubtedly have been sold but for the fact that, as a result of the world war, their price has become very high.

168. Now, let us turn these results into rupees, annas, and pies and see how much the country and the ryots have benefited by the operations of the Agricultural Department in this Circle. Let us take the season 1917-18, a normal one with satisfactory trade conditions. In that season, there were at least 250,000 acres under the Department's "Company" cotton. At a very conservative estimate, an acre of "Company" cotton is worth Rs. 20 more than an acre of the local cotton which it has replaced. This means that the ryots of this tract were gainers to the extent of fifty lakhs of rupees. The net expenditure of the working of the Department that year which produced this result amounted to a little over six lakhs, so that there was a return of over 800 per cent on public money invested in the Department put in the pockets of the people, a return which, even in India, a country of high rates of interest, must be considered a sound financial proposition.

169. Consider next the gain derived by the introduction of drill cultivation. The average total area sown under this new method introduced by the Department for the past ten years has been 10,500 acres. At a very low estimate, the saving effected is not less than Rs. 4 per acre in intercultivation expenses alone, not to mention the higher outturn of cotton as a result of improved cultivation. The total annual saving to the ryots was

Rs. 42,000, while the net expenditure on the whole of the cotton improvement work in the past season was only about Rs. 14,000.

170. Now that the distribution of "Company" cotton seed has been so largely taken up by private merchants and dealers, it is inevitable that the purity of the type should deteriorate. Consequently, the necessity of maintaining the quality by continued selection has been consistently kept in view. At the same time, attention is being devoted to strengthening the existing seed unions and establishing new ones in other parts of the cotton tract.

171. In the Madura cotton tract, the quality of Cambodia cotton has been considerably improved under the advice of the Department by careful methods of cultivation and the operation of the Pest Act. Each year, good Cambodia seed is supplied to cotton cultivators from Coimbatore.

172. Cotton, however, is not the only crop to which the Department has devoted attention in this Circle, or the only problem dealt with. Periamanjal cholam, a variety much superior to the local Irungu cholam, largely used for fodder, has been introduced with success. The value of fish manure has been demonstrated and a large quantity is in demand every year for use on garden crops and wet lands.

173. As in other Circles, the problem of green manuring has been attacked, and the single-planting of paddy taught. Much of the area commanded by the Periyar irrigation system is very alkaline and at first green manure could not be grown. However, after various experiments and trials, green manures have been successfully introduced and the land improved, and now paddy can be grown on it without difficulty. About 40,000 lb. of different green manure seeds, such as kolinji, dhaincha, sunn-hemp, and indigo have been distributed annually for a good many years to the ryots of the Periyar, and it is gratifying to note that as a result of continued propagandist work the sale of green manure seeds is passing out of the hands of the Department into those of private merchants and cultivators. By green manuring, ryots effect a saving of Rs. 15 per acre, on the cost of manuring alone, as it is increasingly difficult

to get green leaf from outside. There are at least 8,000 acres under green manures in the Periyar tract, so that this improvement represents a saving to the ryots of Rs. 1,20,000 per annum. The improvement has a more important bearing than this, however, as the lands had originally a low initial value owing to their alkaline nature. As a result of green manuring, the initial value has increased and is now many times what it was a decade ago.

174. At Michaelpatti, near Kodaikānal Road Station, there is a thriving industry in growing grapes. Complaints were received by the Department that these vines were suffering from disease. This was identified by the Government Mycologist as vine mildew and by way of demonstrating how it could be kept in check, 239 vines were sprayed. The present cost of chemicals necessary for spraying each vine amounts to six annas. The value of the produce from the 239 vines in the years before spraying was done only averaged Rs. 710, but, as a result of the remedy, in 1920 the same number of vines yielded produce worth Rs. 3,950. For an expenditure of Rs. 89 on chemicals a gain of Rs. 3,240 was secured and, in consequence, spraying vines against mildew has become popular and several growers are arranging to purchase spraying machines, so that they can spray their vines themselves.

175. The farm at Koilpatti was opened in 1903. It is on dry land consisting of black cotton soil. Here, the main work is the selection of cotton, and the testing of strains produced both for quality and for acre yield. Many improvements which are the result of experiment in the past are incidentally demonstrated in the ordinary farming practice now adopted on this station, such as the drill system of sowing, a well-defined rotation of crops as opposed to the promiscuous rotation generally adopted in which cotton often follows cotton, labour-saving appliances like monsoon ploughs, baghars, and buck scrapers, clean methods of picking, drying, and storing cotton, and the preservation of cattle manure.

176. A demonstrator was posted last year for work on the wet lands in the Tambraparni valley and he has devoted his energies chiefly to the popularizing of fish guano as a manure for paddy. A good beginning has been made as evidenced by the fact that over 77 tons

have been distributed despite an adverse season with inadequate water-supply. He is also demonstrating green manuring.

177. The future work of the Department in this Circle lies in the direction of the improvement of other crops besides cotton by the introduction of new strains and the study of the manurial problem as it affects paddy. A soil survey of the Periyar tract is being made by the Government Agricultural Chemist and the result of this will throw light on this problem. This necessary work can, however, only be taken up provided that men and money are available.

Seventh Circle.

178. The seventh Circle consists of Malabar and South Kanara and covers an area of 9,816 square miles. The staff comprises a Deputy Director with head-quarters at Tellicherry, four demonstrators and the staff on the farms at Tāliparamba and at coconut stations at Kasaragod, Nileshwar, and Pilicode, respectively. The chief crops are paddy and coconut, while arecanut, pepper, ragi, ginger, and sugarcane are also important. Selected strains of local varieties of paddy have been raised on the Taliparamba farm and each year seed of these is distributed sufficient for 75 acres. The progeny of this seed, which has been distributed now for the last 10 years, has multiplied and spread far and wide over the taluks of North Malabar and Calicut, and it is estimated that there are now 5,000 acres sown with it. As a result of the teaching of the Department, the seed-rate has been reduced by 50 per cent, resulting in a gain of Rs. 3 per acre. Single-planting in Malabar is not advocated as paddy seedlings do not tiller well under local conditions, but the ryots are advised to plant two to three seedlings, according to the fertility of the soil, instead of the local practice of bunch-planting.

179. On the West Coast generally, a large quantity of fish is available as a manure. When the Department first began work, this fish was used mainly for human consumption but experiments conducted at the Taliparamba farm showed its manurial value and a demand has been created. To help the ryots, two depots were established in 1918 and during three years 2,090 tons

of fish guano were purchased and distributed throughout the Presidency. As a result of this propaganda work, the demand for fish manure, both locally and from foreign countries, has become keen. One result of this has been to tempt the manufacturers to adulterate the material with sand. It is now necessary to take steps to stop this and prevent the export in order that the ryot of the country may be able to obtain a cheap and pure material. By the use of this manure, the Malabar ryot gets an increased yield of 30 per cent, as compared with unmanured land, and every rupee spent on this manure returns two rupees on the crop.

180. At the Taliparamba farm, several improved varieties of sugarcane have been introduced and from this centre setts have been distributed throughout South Kanara. The crop, which is new to Malabar, has become established and there are now some 100 acres of it in this district. In South Kanara, the Red Mauritius cane has been introduced by the Department and this and other varieties have practically replaced the local inferior canes. Not only this but the area under this crop has increased from about 2,000 to 3,500 acres. These canes are hard and jackal-proof, and the difficulty in the first instance was that the local mills were unable to crush them, so the much more efficient iron mills had to be introduced to deal with them. The local method of making jaggery was very primitive and the Department has introduced up-to-date methods with improved furnaces and large pans. There are now 485 iron mills and pans in use in the district, as a result of departmental propaganda, and some 2,500 improved furnaces. A comparison between the wooden and iron mills shows that there is a net increase of a candy of jaggery per acre in favour of the latter, and 485 mills are sufficient to crush practically the whole canes out in the district; in other words, there is a net increase of some 3,000 candies of jaggery arising from the use of iron mills, and this alone means a profit of Rs. 50,000.

181. Incidentally, it may be noted that it is the custom for tenants in South Kanara to pay their rent in boiled rice, and this boiling can be done more economically with a saving of fuel if these improved furnaces are used after the cane season is finished. With a given

quantity of fuel, he is able to boil 400 lb. of paddy over an improved furnace as compared with 120 lb. over the local furnace. The introduction of 2,500 new furnaces has, it is estimated, resulted in a saving of Rs. 62,500 per annum in fuel alone required for boiling rice. By the cultivation of the improved canes, there is an increase of at least 25 per cent in yield, viz., 1,500 lb. of jaggery at Rs. 50 per candy. The increase in money value of the cane crop over 3,500 acres is Rs. 5,25,000 due to the introduction of these canes by the Department.

182. The total monetary gain to the ryots as a result of the improvements introduced by the Department in the sugar industry in this district amounts to over nine lakhs of rupees (vide Appendix A).

183. The Taliparamba farm was originally started in 1905 for the study of the pepper vine and its cultivation. The improvement of this valuable crop has been demonstrated along lines of planting good varieties. It was found that the crop was poor in many places because a bad variety was planted having only female flowers, which are often unfertilized and in consequence the pepper fails to set. Manurial experiments have also been conducted with pepper resulting in improved yield. Poor gardens which would ordinarily have been abandoned have been resuscitated by regular cultivation, coupled with the application of lime, leaf mould, and fish guano.

184. On the dry lands, the local system of cultivation is known as "punam"; that is, once in five or more years, a crop of paddy yielding about 500 lb. an acre and worth about Rs. 25 is grown. This means an annual income of some Rs. 5. It has been proved on the farm that by systematic cultivation an average yearly income of Rs. 30 can be obtained.

185. Tapioca is another crop which has recently been newly introduced by the Department into South Kanara. This crop is extensively grown in Malabar where it is very profitable besides furnishing a cheap food to supplement the rice crop. Its extension will especially benefit petty cultivators and members of the depressed classes who are being encouraged to cultivate this crop near their houses.

186. More recently, the Department has taken up the study of coconuts on the West Coast, an industry which occupies 3,694·89 acres in this Circle. This is entirely new work. That the yield of coconuts can be considerably increased by regular cultivation, which induces a deeper root system, and by the maintenance of a soil mulch can be easily proved and this is being demonstrated to the growers. At the coconut farm at Kasaragod, a plot which received systematic cultivation gives on the average 32 nuts per tree as compared with 15 nuts from uncultivated trees. The problems relating to the methods of raising seedlings, planting, manuring, harvesting, copra-making, and the manufacture of sugar from the sap, are all now under investigation by the Department.

187. There are about 76,000 acres under arecanut in Malabar, over a quarter of this being situated in the Ponnani taluk Here, a fungus disease, known locally as Mahali or Mahakali, is very virulent, causing great loss. The Government Mycologist has found that spraying the fruit bunches with Bordeaux Mixture mixed with resin protects them from the disease. The loss which was being caused by the disease was estimated at as much as Rs. 50 per 100 trees in many cases, and the annual loss over the planted area is estimated to amount to as much as Rs. 6,50,000. The cost of spraying 100 trees is trivial, viz., Rs. 2; so that for a small expenditure, the Department has shown how this huge drain on the arecanut crop can be avoided.

188. The main difficulties encountered by the Department in its work in this Circle, and especially in the Malayalam country, is first the general poverty of the actual cultivators who are more often than not poor tenants having little interest in land improvements as they have no fixed tenure, and, secondly, the laws of inheritance peculiar to Malabar. This is specially the case in rice lands where the cultivators, being illiterate and ignorant, are afraid to take up improvements lest they should be called on to pay more rent. The personal influence and tact of the demonstrators is the only means of overcoming these difficulties.

Eighth Circle.

189. The eighth Circle comprises the districts of Salem and Coimbatore and is in the charge of a Deputy

Director, with head-quarters at Coimbatore, and ten demonstrators.

190. There is a farm at Anamalai for the study of Cambodia cotton and the Central Farm at the Agricultural College also serves to demonstrate improved methods of agriculture, such as the use of improved ploughs and implements, improved furnaces for jaggery-making, the use of manures, and dairying. The activities on this farm have already been described.

191. Since 1912, steady progress has been made in this Circle in spreading the knowledge of the advantages of single-planting of paddy, and a modest estimate shows that this method has been introduced by the efforts of the Department over 21,950 acres and has resulted in a saving of Rs. 77,000.

192. In the west of the Salem district, dhaincha has been introduced as a green manure crop and large areas of this are to be seen in the Attur taluk where its cultivation has become a regular agricultural practice. A small quantity of seed of this is sown as a mixture with cumbu which is grown on wet lands supplemented by wells as a first crop prior to the receipt of the water in the North-East Monsoon season. After the cumbu has been harvested, dhaincha is puddled into the soil as a manure for the following paddy crop. This has meant a very considerable saving to the people,—the cost of growing green manure crop is small—while much time and money is saved in collecting and carting forest leaves.

193. In the areas irrigated under the ayakut of the Bhavani river in the Gobichettipalaiyam taluk, vast areas of wild indigo, aggregating to some 8,000 acres, are to be seen in the dry weather after the paddy has been harvested. The introduction of this practice at a moderate estimate can be valued at not less than one and a half lakhs of rupees. Up to last year, arrangements for the supply of seed have been made by the Department but this year private enterprise has sprung up which has taken over this work. This has enabled the Department to introduce similar work in other areas.

194. Improved strains of Cambodia cotton have been raised by the Department and these are now being grown by ryots on contract under seed-farm conditions.

Last year, the area of these seed farms was 600 acres. By this means, 3,000 bags of seed of these improved strains were available for sale to the public. Crops raised from this seed not only give an increased yield, but command a better price. The cotton obtained from these seed farms during the last two years has been sold by auction in Tiruppur and in both seasons the price realized has topped the market. It is estimated that this work brings in a profit to the grower of not less than two lakhs per annum. On some of these seed farms, fish guano has been tried as manure for Cambodia cotton and it is estimated that the increased crop brings in a return of Rs. 70 per acre on an expenditure of Rs. 15, leaving a net profit of Rs. 55.

195. The introduction of the Pest Act into the Coimbatore district in the last three years to control the ravages of the "pink boll worm" has resulted in a decided improvement in the quality of the cotton produced, as instanced by the present quotations on the Tiruppur market.

196. Recently, work has been taken up by the Government Mycologist for the treatment of "smut" in cholam, and the value of soaking seed in a solution of copper sulphate as a protection against this disease has been successfully demonstrated in several centres.

Planting Districts.

197. The Planting Districts of South India are found in the hills of Malabar, the Wynaad, the Nilgiris, the Shevaroys, Coorg, and the Anamalais in the Presidency, and in Mysore, Cochin, and Travancore in Indian States.

198. The main crops raised are coffee, tea, and rubber, with a certain amount of cardamoms and pepper, and a little fibre, fruit, and minor crops. Coffee is grown largely by private proprietors and a large acreage in Mysore is in the hands of small owners on garden lands. The tea and rubber are chiefly in the hands of large European companies, but there is an increasing tendency for Indians to plant rubber in Travancore.

199. Scientific advice is given about these industries by a Deputy Director with head-quarters at Coimbatore, and four farms have been established, one for coffee at

Sidapur in Coorg, one for tea at Peermade in Travancore, and two for rubber, one in the Cochin State and one at Tenmalai in South Travancore. The Indian States concerned and the United Planters' Association of Southern India contribute a share to the cost of the establishment. Recently, a Mycological station has been established at Mundakayam and a Mycologist appointed to study the diseases of rubber. The cost of this establishment is met by the United Planters' Association, but the Rubber Mycologist is an officer of the Department.

200. The work of these officers is chiefly advisory, and deals with manurial and cultivation problems, methods of harvesting and marketing, and the control of diseases. The aid of the experts at the Research Institute is called in whenever necessary.

201. One of the great problems faced by planters is that of soil erosion. The estates are situated on steep land in the hills in areas of high rainfall and when the jungle is cleared to plant tea and rubber, there is apt to be loss of soil due to erosion. This is more particularly the case as a system of clean weeding is usually adopted. The Department has endeavoured to combat this bad agricultural practice and to teach and demonstrate the use of cover crops and the value of green manures, not only as soil preservatives, but as soil renovators. Considerable success has been met with and it is more and more common now to see large areas under a cover of some green manure.

202. With the aid of the Department, two improved strains of coffee have been isolated, the seed of which is now available and rapidly becoming popular both in India and in other coffee-growing countries like East Africa.

203. The control of diseases occupies a great deal of the attention of the Department and notable advances have been made, spraying has been introduced, and modern methods of pest control introduced and demonstrated.

CHAPTER VII.

THE FARMS.

204. Each Government farm is in the charge of a farm manager with one or more assistant farm managers, and they have a dual function. First, demonstration: they are used to demonstrate improved methods of cultivation, such as single-planting of paddy, drilling of seed, eradication of weeds, the use of monsoon ploughs and other implements. Here, the neighbouring ryots can see for themselves how these improvements are carried out and the benefits which accrue from them. The ryot is very often described as being conservative, but this has not by any means been the experience of the Agricultural Department. He is found to be very shrewd and if time and trouble are taken to explain a point of view to him, he is quite open to conviction. Better still, however, is demonstration. He prefers to be convinced through his eyes and not through his ears, but both methods are open to the man with the will to make use of them. The second function of the farms is perhaps still more important, viz., a place where systematic experiments can carried out and their results recorded. The farms are be used to test improved strains and compare them with one another and with local varieties in order to ascertain which are the best and the degree of their value.

205. Manures of various kinds are tested on the different crops under different conditions, spacing experiments are conducted, and so on. Also, a good deal of miscellaneous experimental work is carried on. Whenever any question arises which is amenable to direct field experiment, the farms are naturally looked to as suitable places on which to conduct such experiments. This is work which does not lend itself to description but an example may be given.

206. European countries are more and more turning to synthetic products for their nitrogen supply and we hear a great deal about the synthetic production of sulphate of ammonia, nitric acid, and nitrolim. Now, India, with her vast sources of water power running to waste, seems to be an ideal place for the synthetic production of nitrogenous manures and schemes are often mooted for developing these resources.

207. We must, however, first discover whether such manures are suitable to Indian crops, climate, and soil. Nitrolim, for reasons which need not be gone into here, appears to be the most promising of these fertilizers and experiments are being conducted on the farms with a variety of crops under a number of different conditions of soil and climate to test the value of this manure with a view to its possible manufacture on a large scale in India. So far, the results obtained have not been at all conclusive and it will probably take some time before any definite opinion can be come to.

208. Now, when a large number of experiments of this kind are made, many must perforce give negative results and be abandoned. The value of a negative result is often as great as that of a positive one since it shows the "closed road" and indicates that it is useless to pursue inquiry any further in this particular direction.

209. The layman is often apt to think that work which leads to negative results, or to no result at all, is a waste of time and money, but this is not really the case. Scientific research work is essentially work of searching continually for an explanation, and every attempt cannot be a success.

210. One may compare the case of the invention of the flying machine. From the time the brothers Wright first learned to glide a few hundred yards through the air to the present time when hundreds of machines are flying every day and when mails and passengers are being carried regularly over long distances, how much money, how much material, how many lives have been sacrificed? Was this waste? Most assuredly not! The result has been achieved.

211. So with scientific agriculture. Not every line of inquiry leads at once to success, not every experiment gives a result, but are the money and brains expended upon these abortive results wasted? Again, most assuredly not! A single success may more than compensate for all the failures or negative results and, what is more satisfactory perhaps, the layman more pays for all effort and money which has been expended on failures.

212. Farms used for experimental work can, under no circumstances, be run "to pay." It would, of course,

be quite possible to run a farm on profitable lines if it were purely demonstrational. In the Federated Malay States, such a farm exists. There, a rubber estate is run by the Agricultural Department on the most approved and up-to-date scientific lines with the object of raising revenue. This policy, however, has not been adopted in India and, as far as the Government farms are concerned, demonstrational and experimental work have not been separated. Their value lies in both these aspects of the work.

CHAPTER VIII.

DEMONSTRATION.

213. One of the methods adopted by the Department in order to spread the knowledge of the improvements which it wishes the ryots to adopt is that of actual demonstration in the villages as well as on the farms of the improvements. This aspect of the propaganda work of the Department is new but as experience is gained, it is becoming successful and is being more and more developed. New processes, new strains, new implements are put in the hands of local agricultural demonstrators and assistant demonstrators each in charge of a certain number of villages and in close touch with the ryots. The demonstrators explain to the cultivators the objects of the new improvement and induce the ryots to give it a trial in their lands. The work is undertaken on the ryot's own lands with his consent, and the Government supply the seed manure or implement, as the case may be. A cultivation sheet is maintained of the demonstration showing a profit and loss account so that the ryot may see exactly the benefits to be obtained for the improvement which is being demonstrated. In this account, the ryot himself supplies all the figures relating to the cost of cultivation.

214. Valuable results have ensued from this method of propagating new practices and implements and ryots have come forward in many places to place their lands at the disposal of the Department for these demonstrations.

The practices demonstrated have, in many cases, been copied by the neighbours and relatives of such ryots.

215. This scheme gives the ryot a direct interest and incentive in the experiments undertaken on his land and keeps him in touch with the work from the beginning to the end and the Department familiarizes the ryot by actual demonstration with the character and objects of the improved methods and their practical working. Moreover, the ryot sees the improvement in question actually take place on his own lands under his own management and handling and this removes the tendency which is apt to exist of thinking that what the officers of the Agricultural Department can do on a Government farm cannot be done by the ryots themselves on their own land, because of some secret nostrum or some excellent fertility of the farm lands. Also, it does away to a large extent with that obstacle to success, the idea that Government have some ulterior motive in inducing the ryot to introduce improvements.

216. When the ryot sees the improvement actually carried out on his own land and he reaps the monetary benefit from such an improvement, he realizes that there is not "a catch somewhere" and that it is really true that the Department is a benevolent one working for his good.

217. The number of demonstrators available for this work is necessarily limited at present and in order that they may carry out the work efficiently, it is necessary to concentrate their efforts in a limited number of localities since each actual demonstration undertaken takes time and constant supervision necessitating the constant presence of the demonstrator and frequent visits from him. Despite this, however, the concentration of demonstrators is kept as fluid as possible and when touring officers of the Department come across places where it is obvious that the activities of a demonstrator are specially needed or would be specifically beneficial, such a demonstrator is sent there as soon as he can be spared.

218. Moreover, as soon as a new improvement has become popular in any group of villages and it is felt that it is firmly established, the demonstrator can

be moved to a fresh group where improvements are unknown, with only occasional visits to the first group where success has been obtained. In this way, a number of "centres of infection," so to speak, are established from which knowledge spreads.

219. The question of holding annual conferences with ryots at the time of festivals and religious holidays at different centres in each district is also being examined. Some work along this line has already been done and has met with success. Advantage is taken of cattle fairs, etc., to hold small agricultural exhibitions at which samples of improved strains of seed produced are exhibited, ploughing and drilling demonstrations and improved cattle-sheds and sugar-boiling pans are erected and explained, and magic lantern lectures are given dealing with pests and deceases of crops and how to deal with them, and agricultural improvements are generally given. Departmental literature is distributed and sold on these occasions. This side of the propaganda work of the Department will be developed as men and money become available.

CHAPTER IX.

SUMMARY OF WORK DONE.

220. Appendix A gives general estimates of the increase—both present and ultimate—in the annual income of the ryots, due to the adoption of the improvements recommended by the Agricultural Department. Care has been taken to assess each improvement at its minimum money value. A perusal of the preceding pages will show that many items of improvement have not been included in the appendix, either because their money value is comparatively small at present or because they have not yet passed the experimental stage. These items contain, however, the germs of progress.

221. The increase in the annual income of the ryot population in 1921–22 from such improvements as have got beyond the experimental stage is estimated at Rs. 2¼ crores compared with a net expenditure in that year of about 10 lakhs on the Agricultural Department.

Thus, the return to the country was Rs. $22\frac{1}{2}$ for every rupee spent on the Department. This shows that a comparatively small expenditure by Government on the Department brings in a very large return to the people—a result which has not been shown by any other Department spending money from current revenues and not from capital amounts like the Irrigation Department.

222. The total net expenditure on the Agricultural Department, including all outlay on salaries, research and experimental work and agricultural education during the sixteen years beginning with 1906–07 when it was reconstituted, is only about 80 lakhs, or less than three-eighths of the amount now returned to the country in one year alone. This proportion will be only about one-third if we exclude the amount spent on the pumping and boring section during the four years when it was under the Agricultural Department.

223. With the provision of more funds for the Agricultural Department, it will be possible to engage in research and propaganda work on a greater scale than before. It is not only advisable, but it is essential if the food production of the country is to keep pace with the growth in population. The necessity for doing such work is urgent as even now the Presidency is not independent of outside supplies of food grains and pulses. The money which is spent on the Department benefits the primary industry of the Presidency.

224. Appendix B gives a list of the publications of the Madras Agricultural Department.

CHAPTER X.

CONCLUSION.

225. It will be seen from the above account of district work that there still remain large areas of the Presidency untouched by the Agricultural Department. This is due to lack of staff, for which there is an increasing need, and it is found better to concentrate the staff available on certain definite areas and lines of work rather than fritter away their efforts over a wider area.

The Department will have to be considerably enlarged before it can deal thoroughly and efficiently with the whole of the Presidency and there is especial need for well-trained men for district work. That the Department is doing its best to cope with the many problems presented to it over a cultivated area of something like 39 million acres with its present limited resources has, it is hoped, been indicated in this account of its activities.

226. It may seem to some that to increase the profit on some one crop by Rs 5 an acre is a small result achieved by a large and well-equipped Agricultural Department; but a moment's thought will convince one that, when Rs. 5 is multiplied by the large figures representing the acreage under crops in the Madras Presidency, the achievement is a very large one when converted into money. There are, for instance, over 11 million acres under rice in the Presidency. Suppose that, by the use of new strains made by the Government Economic Botanist, by improved cultural methods and by manuring, all of which are amply demonstrated by the Department, the yield was raised but by the small amount of 15 lb. per acre, the result would be rice to the value of over 80 lakhs of rupees, which would more than pay for eight times the whole upkeep of the Department. This, for one crop alone! Enough has been said to show the possibilities, the goal to be aimed at, the compensation for the "waste."

227. The success achieved by the efforts of the Department results in crores of rupees being added to the wealth of the Presidency each year, rupees which find their way direct into the pockets of the ryots, the actual producers, and thus enable them to raise their standard of living and development. An Agricultural Department is a development department, and as such, should not be crippled for want of funds. Its chief needs at the moment are more men and more money so that it may solve problems yet untouched and spread the knowledge of improvements, known to be financially sound, into new areas.

228. It may be noted that the net expenditure on the Department during 1920–21 was Rs. 9,50,445, which works out at less than 5 pies per cultivated acre of the Presidency. This may be compared with America, a country which has realized that one of the best ways of investing public money is in the improvement of the country's agriculture, and which spends 15 annas per cultivated acre on its Agricultural Department.

APPENDIX A.

Statement showing the gain (both present and prospective) to the ryots in the Madras Presidency by the work of the Agricultural Department.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I Circle (Agency Division, Ganjām, Vizugapatam, Gōdāvari, and the five northern taluks of Kistna, i.e., Yernagudem, Tanuku, Narasapur, Bhimavaram, and Ellore).—Cultivated area 8,345,000 *acres; paddy* 4,179,000 *acres, including an area of* 1,204,000 *acres under rain-fed paddy; sugarcane* 51,200 *acres; plantain* 19,500 *acres.*								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy ...	Cultivation of improved strains.	14,000	$4\frac{1}{2}$	63,000	240,000	$4\frac{1}{2}$	10,80,000	*Col.* (3) relates mostly to *Rasangi* 3 and *Konamani* 3, grown mainly in the taluks of Ramachandrapuram, Cocanada, and Amalapuram. They are pure selections of delta paddy varieties grown at the Samalkota farm. They ripen uniformly and yield about 100 lb. per acre more than the varieties ordinarily cultivated. They also command a higher price but this has not been taken into account here. The figure in column (6) represents one-fourth of the area under irrigated paddy in the delta taluks of the districts of Gōdāvari and Kistna. The strains in question cannot suit all the varying conditions of the deltas.
Do. ...	Economic transplantation or the reduction in the seed-rate used for transplanted paddy.	93,100	about $3\frac{1}{5}$	2,97,100	1,000,000	About $3\frac{1}{8}$	31,55,000	*Col.* (3).—Gōdāvari 55,000 (about 50,000 acres in the Ramachandrapuram taluk); Vizagapatam 38,000. *Col.* (4) represents only the saving in seed and labour. There is, besides,

								an increase in yield. These remarks apply also to the other circles. The gain is greater in the Gōdāvari district, where the lands are more fertile than in Ganjām and Vizagapatam. *Col.* (*6*).—Generally speaking, the transplanted area under paddy depends on the sufficiency of water-supply and the availability of labour. It is only the irrigated variety that can be transplanted. About one-third of the area under irrigated paddy in Ganjām, half of the area in Vizagapatam, and most of the area in Gōdāvari are transplanted. In the Agency Division, the crops have to depend mainly on rain. For the most part, paddy is transplanted in Ganjām on wet lands under channel irrigation. But more than 70 per cent of the area is irrigated from tanks and "other sources" and these wet lands are inclined to be precarious. Much of the area in Vizagapatam is broadcasted as there is not sufficient water in tanks and as paddy has therefore to depend largely on rain. In Gōdāvari, irrigated paddy is raised mostly by transplantation. Economic planting was practised in Kistna even before the advent of the Department. *Col.* (*7*).—Rs. 5 per acre will represent the gain to the ryots by planting paddy seedlings singly or by twos and threes according to the fertility of the land. The usual seed-rate is very excessive and varies from 60 to 150 lb. per acre except in Kistna, where it is not more than 25 to 30 lb. per acre. Better crops are obtained by reducing the seed-rate in the seed-bed so as to obtain strong, healthy seedlings and by transplanting them singly so as to leave them room to tiller. This reduces the seed-rate to 20 lb. per acre and even less on good lands. As early as 1912–13, many ryots valued the improvement at Rs. 7 an acre. But ryots have not yet adopted single-seedling on an appreciable scale though they have reduced the seed-rate. These remarks apply to all Circles.
Do. ..	Application of bone meal and fish guano.	1,000	5	5,000	...	...	...	*Cols.* (*6*) *to* (*8*)—It is not possible to fill in these columns for each Circle because the limit of area for the use of concentrated manures like fish manure, bone meal and oil cake is the amount of the manures available. This can be worked out only for the whole of the Presidency. The summary at the end gives (1) the area in the Presidency on which concentrated manures which are now exported can be applied if their export were stopped and (2) the prospective gain to the ryots by stopping their export. These remarks apply to all Circles.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I Circle (Agency Division, Ganjām, Vizagapatam, Gōdāvari, and the five northern taluks of Kistna, i.e., Yernagudem, Tanuku, Narasapur, Bhīmavaram, and Ellore).—Cultivated area 8,345,000 *acres; paddy* 4,179,000 *acres, including an area of* 1,204,000 *acres under rain-fed paddy; sugarcane* 51,200 *acres; plantain* 19,500 *acres*—cont.								
		ACRES.	RS.	RS.	ACRES.	RS.	RS.	
Paddy —*cont.*	Growing of green manure crops.	6,000 mainly in Rāma-chandra-puram taluk.	5	30,000	1,000,000	5	50,00,000	The improvement refers to the growing of leguminous crops on the land with the object of ploughing them in as manure to the paddy crop. They may either be sown in the off-season or before harvest on the standing crops of paddy. The raising of such crops during the hot months depends on timely and copious summer rains or supply of channel water. In fact, green manuring would be confined almost entirely to the lands which are transplanted. These remarks apply to all Circles. Ryots in the I Circle grow dhaincha in their field bunds, collect their own seed, and sell the surplus to others. *Col.* (*6*).—represents one-fourth of the area under paddy in Ganjām and Vizagapatam, half of the area in Gōdāvari and one-third of the area in Kistna. The scope for green manures is not large in Ganjām and Vizagapatam as the crops have to depend largely on rain. The use of green manures (sunnhemp and green gram) is already well known in parts of the Gōdāvari district. A large area in Kistna already grows sunnhemp for fodder.
	Total Paddy ...	...	...	3,95,100	...	...	92,35,000	

Sugarcane.	Extension of area under improved varieties.	8,100 mainly in Godavari.	300	24,30,000	8,100	300	24,30,000	*Col.* (3).—The area under Sugarcane in the Gōdāvari district has increased from 4,975 acres in 1902-03 when the Samalkota farm was opened to 13,000 acres in 1921-22. The increase is due to the introduction of Red Mauritius and other exotic varieties which are resistant to a large extent to the "red-rot" fungus which was causing much loss to the local canes. A good crop of purple Mauritius yields as high as 4½ tons of jaggery. *Cols.* (4) and (7).—The gain of Rs. 300 per acre represents the difference between the net profits per acre of sugarcane and paddy (Rs. 370 and 70, respectively.)
Do.	Replacement of the local canes by improved varieties.	5,300 mainly in Gōdāvari.	200	10,60,000	26,600	200	53,20,000	*Col.* (4).—The difference in yield between the exotic varieties and the local varieties displaced by them is at least ¾ ton of jaggery, the value of which at present prices is not less than Rs. 200. This is based on the assumption that the cane crop in Gōdāvari would have survived the onslaught of the red-rot disease (*Colletotrichum*). But it was reported that the crop was threatened with extinction when work was commenced in 1902, in which case the lands would have been cropped with paddy. Hence, really the work of the Department has resulted to the ryots in a gain of 5,300 (acres) × Rs. 300 (per acre) or Rs. 15,90,000. *Col.* (6).—The area in this column excludes an extent of over 16,000 acres in Vizagapatam which is under introduced varieties of sugarcane as a result of the work of the late Mr. Gillman, who imported these from Mauritius in 1896 when he was the Estate Collector of the Vizianagram Zamindari.
Do.	Planting canes in lines and reducing the seed-rate.	100 in Gōdāvari	65	6,500	51,200	65	33,28,000	Sugarcane setts are usually sown broadcast between the irrigation and drainage furrows made in the land and trodden in. Between 20,000 to 30,000 setts are used per acre. But by planting canes in lines, a good deal of labour is saved for all the operations during cultivation (wrapping the canes, weeding, irrigation, etc.) and supervision is rendered easier. This means a saving of Rs. 50 per acre. The number of setts per acre can also be reduced to 15,000, thus effecting a saving of at least Rs. 15 per acre with setts at Rs. 3 per thousand. Planting in lines is largely the practice in the southern part of Vizagapatam, where it was practically unknown ten years ago but the ryots plant the setts closely; this area is not included in col. (3).
	Total Sugarcane ...	...	...	34,96,500	...	...	1,10,78,000	

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Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I Circle (Agency Division, Ganjām, Vizagapatam, Gōdāvarī, and the five northern taluks of Kistna, i.e., Yernagudem, Tanuku, Narasapur, Bhimavaram, and Ellore):—Cultivated area 8,345,000 *acres; paddy* 4,179,000 *acres, including an area of* 1,204,000 *acres under rain-fed paddy; sugarcane* 51,200 *acres; plantain* 19,500 *acres*—cont.								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Plantains...	Introduction of the improved method of cultivation (South Indian system) in the Gōdāvari district.	340	300	1,02,000	6,900	300	20,70,000	The South Indian system consists in planting *single* suckers when very young, the spacing being ten links apart. Thus, 1,000 suckers are planted per acre against the local method of 200 pair of full-grown suckers. The land is then manured heavily; side-shoots are removed till bunching time and the crop is treated as an annual like sugarcane, the field being cleared in about 12 to 14 months. The local method of cultivation hardly gives an annual net income of Rs. 150—200 per acre, while the improved method gives Rs. 500 per acre.
Palmyras...	Operations against the bud-rot (*Pythium palmivorum*) disease of palmyras in the districts of Gōdāvari and Kistna.	500,000 trees.	Rupee one per tree.	5,00,000	500,000 trees.	Rupee one per tree.	5,00,000	The disease is due to a fungus. The only remedy for it is to cut away and burn all diseased tissue before the growing tip is affected. Government have been conducting operations against the disease for a long time. It has now been brought under control and the palmyra industry has, it is hoped, been saved from ruin. The figure in column (3) represents an estimate of the number of trees which are tapped for sweet juice, etc. *Col.* (*4*).—During a season of five months, a tapper is able to deal with 80 trees which are estimated to yield from 5 to 6 candies of jaggery. A net gain of rupee one per tree per annum is a modest estimate. All products of the palmyra palm are useful.

	Total I Circle ...	...	...	44,93,600	...	...	2,28,83,000	*General remarks.*— 1. The Department has done no work till now in the Agency Division. 2. The figures for the southern taluks of Kistna have been included in the figures above for the sake of convenience. It is not possible to separate the figures in all cases. 3. The crops dealt with are paddy, sugarcane, plantains, and palmyras.

II Circle (Southern taluks of Kistna, Guntūr, and Nellore—a newly formed Circle where work is being started).—Cultivated area 3,903,000 acres; paddy 794,000 acres; turmeric 5,600 acres.

Paddy ...	Fish guano	400	5	2,000	...	...	...	*Col.* (*6*).—This represents one-third of the area under irrigated paddy in Guntūr under the Kistna delta and about half of the area under irrigated paddy in Nellore. In Guntūr, sunnhemp is already largely grown for fodder purposes after the harvest of paddy; the delta ryots also apply their surplus paddy straw as manure to their fields. The South-West Monsoon in Nellore is precarious. Green manures would be confined mainly to single-crop paddy lands under the Pennar canals system.
	Growing of green manure crops.	500	5	2,500	300,000	5	15,00,000	
	Total Paddy ...	...	...	4,500	...	...	15,00,000	
Turmeric...	Improved furnace ...	15	10	150	5,200	10	52,000	*Col.* (*4*).—This represents the saving in fuel by using the sugar-pan and Sindewahi furnace. The local method of curing and drying turmeric is wasteful of fuel. The gain of Rs. 10 does not take into account the better price obtained for the turmeric on account of its superior quality due to the uniformity in boiling.
	Total II Circle ...	...	...	4,650	...	...	15,52,000	*Note.*—See general remark 2 against I Circle. The crops so far dealt with are paddy and turmeric.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
III Circle (Kurnool, Bellary, Anantapur, and Cuddapah).—Cultivated area 7,712,000 *acres; paddy* 372,000 *acres; cholam* 2,061,000 *acres; sugarcane* 12,000 *acres; cotton* 1,000,000 *acres.*								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy ...	Economic transplantation.	200 in Kurnool and Bellary.	3	600	30,000	3	90,000	*Col.* (*6*).—The transplanted area is small in this Circle owing to want of sufficient water for irrigation in canals and tanks. Transplanting is not in vogue in Bellary. Paddy is seldom transplanted in Anantapur. The area under paddy irrigated by classes I and II works (Kurnool-Cuddapah canal, Chepad channel, etc.) in Kurnool and Cuddapah is about 54,000 acres, but the whole of this area cannot be transplanted owing to the uncertainty of the water supply. *Col.* (*7*).—Rs. 4 will represent the gain to the ryots by adopting single-seedling wherever possible.
Do. ...	Application of concentrated manures.	500 in Kurnool and Bellary.	10	5,000	...	...	...	......
Do. ...	Growing of green manure crops.	500 in Kurnool and Bellary.	5	2,500	30,000	5	1,50,000	*Col.* (*3*) includes the area under green manure crops grown from seed distributed by merchants and the local co-operative society in the Hospet division where the Department has discontinued this distribution as the advantages of green manuring are now well known.
	Total Paddy ...	...	...	8,100	...	...	2,40,000	

Cholam ...	Cultivation of selections from local cholam-T$_1$ in Bellary and T$_6$ in Kurnool.	2,450 (2,000 in Bellary).	3	7,300	350,000	3	10,50,000	*Col.* (*3*) gives the area in 1921-22. The strains in question yield higher than the local varieties. *Col.* (*6*).—Represents about a fourth of the area under cholam in Kurnool and Bellary. The strains cannot suit all the varying conditions of the whole area.
Do. ...	Soaking cholam seed in a solution of copper sulphate before sowing as a preventive of smut.	47,450 (Kurnool 36,450; Bellary 11,000).	1½	71,200 (1,42,300)	2,000,000	3	60,00,000	*Col.* (*5*).—The season in 1920–21 was bad. The figure in brackets show what the gain would have been in a normal season. *Col.* (*6*) represents the total area under cholam in the Ceded districts. The damage to the crop by sowing untreated seed is placed by some as high as 32 Madras measures per acre. The cost of the copper sulphate required is trifling, about half an anna per acre.
	Total Cholam ...	...	...	78,500	...	...	70,50,000	
Cotton ...	Replacement of the local cotton by Nandyal 14 (a strain evolved from the local cotton) in the "Northerns" tract.	30,000 (Kurnool)	About one rupee.	31,000 (2,10,000)	400,000	7	28,00,000	*Col.* (*2*).—N. 14 is a white cotton of good length and strength. It gives a higher yield than the local cotton which is a mixture of red and white cotton. *Col.* (*5*) represents the profit in the abnormally bad season of 1920–21 from 17,000 acres on which extent alone N. 14 was grown pure. The figure in brackets shows what the gain would have been in a normal season. *Col.* (*6*) gives the average area in the taluks of the Kurnool district (with the exception of Cumbum and Pattikonda), of Jammalamadugu and Proddatur of the Cuddapah district and of Tadpatri in the Anantapur district and in the Banganapalle State.
Do. ...	Replacement of the local cotton by Hagari 25 in the "Westerns" tract.	12,000 (Bellary).	$\frac{1}{3}$	4,000 (30,000)	600,000	2½	15,00,000	The local cotton is a mixture. H. 25 is an improved strain. *Col.* (*5*) represents the profit in 1920–21, when the season was bad. The figure in brackets shows what the gain would have been in a normal season. *Col.* (*6*) gives the average area under cotton in the Bellary district and in the taluks of Gooty, Pattikonda, and others in the Westerns tract.
	Total Cotton ...	...	...	35,000	...	...	43,00,000	

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
III Circle (Kurnool, Bellary, Anantapur, and Cuddapah).—Cultivated area 7,712,000 acres; paddy 372,000 acres; cholam 2,061,000 acres; sugarcane 12,000 acres; cotton 1,000,000 acres—cont.								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Sugarcane.	Improved furnaces in Kurnool.	30	25	700	200	25	5,000	The local furnaces are small, are not provided with chimneys and use considerable wood as fuel. The improved furnaces are bigger with fairly tall chimneys. No extra wood is used as fuel as the megass and trash from the cane itself are sufficient. *Col.* (4) represents the saving in fuel per acre.
	Total III Circle ...	...	...	1,22,300	...	...	1,15,95,000	The crops dealt with are paddy, cholam, sugarcane, and cotton.
IV Circle (Chingleput, North Arcot, South Arcot, and Chittoor).—Cultivated area 4,716,000 acres; paddy 1,874,000 acres; sugarcane 10,400 acres.								
Paddy ...	Cultivation of improved varieties.	2,000	16¼	32,500	170,000	15	25,50,000	Chitrakali and Svarnawari are recommended as second crop varieties in the districts of North Arcot and Chittoor. They are short duration varieties (3–3½ months) and hence the cost of irrigation is considerably minimized in places which depend on tanks or spring channels for their water.

								Thus, if the season fails after three months, which is not uncommon, the varieties in question can be harvested with the aid of one or two irrigations from wells in the land whereas the local crop, being of five months' duration, will have to be irrigated for two months at an expense of Rs. 16 to 20. Poombalai, a native of Tinnevelly and a fine white-riced *Samba*, is a five-months crop which is recommended when the season for samba is too late. The local practice in such cases is to sow a kar crop the rice of which is coarse and red. Poombalai commands a higher price than kar. The extra gain on this account alone is not less than Rs. 20 per acre. Ramagarudan samba is a selection from *Garudan Samba* which it has replaced in a number of villages round Palur and yields 15 per cent more. *Col.* (*6*).—The area under irrigated paddy in the circle is about 1,700,000 acres. This includes single and double crop lands, kar and samba areas and lands with an assured supply of irrigation as well as a precarious supply. Local conditions also vary largely over the area. It is estimated therefore that these varieties will suit some 10 per cent of the area.
Do. ...	Economic transplantation.	100,000 (Chingleput 38,000, South Arcot 60,000.)	3½	3,50,000	500,000	3½	17,50,000	*Col.* (*3*).—Several villages in South Arcot have adopted single planting of paddy seedlings. *Col.* (*6*).—Very large areas in Chingleput, especially the paddy sown in August, September, are either broadcasted or drilled. Large areas in South Arcot are sown broadcast. Broadcasting is a common practice in most parts of North Arcot and Chittoor; transplanting is more or less confined to the samba crop. About 30 per cent of the area under irrigated paddy in the Circle is therefore taken as being transplanted. *Col.* (*7*).—Rs. 3½ is taken on the basis of the present reduced seed-rate. This can be reduced still further when the improvement will be worth about Rs. 5 per acre.
Do. ...	Application of fish guano and oil-cakes.	1,200	10	12,000	...	...	...	

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IV Circle (Chingleput, North Arcot, South Arcot, and Chittoor).—Cultivated area 4,716,000 *acres; paddy* 1,874,000 *acres; sugarcane* 10,400 *acres*—cont.								
		ACS.	RS.	RS.	ACS.	RS	RS.	
Paddy—*cont.*	Growing of green manure crops.	6,000	8	48,000	350,000	8	28,00,000	The practice of collecting green leaves from forests, carting them to the fields, and applying them on the land has been in vogue for many years. With the extension of cultivation and with the restriction in the supply of leaves from the local forests, such manuring has become more and more difficult. Raising green manure crops is much less expensive and involves less labour and trouble. The net profit obtainable from growing green manure crops varies with the distance from which green leaves have to be brought. These remarks apply also to the VI and VIII Circles.
	Total Paddy ...	...	...	4,42,500	...	...	71,00,000	

Col. (3).—Green manure seeds sufficient for 930 acres were distributed by the Department in 1920–21. More than five times this area would have been sown by ryots with their own seed or with seed purchased from others or with self-sown kolinji which gets itself established when sown in single crop wet lands for two or three years.

Col. (4).—At least two cart-loads of tree leaves collected from forests are applied per acre. The cost, including carting, is estimated at Rs. 10 to 12. The cost of raising a green manure crop and ploughing it in is only Rs. 2 to 3. And a green manure crop usually adds to the soil by far a larger quantity of vegetable matter than any possible heavy dose of carted leaves.

Col. (6) represents about 20 per cent of the area under irrigated paddy in the Circle.

Sugarcane.	Extension of area under improved varieties.	1,800	200	3,60,000	1,800	200	3,60,000	*Col.* (3).—Relates to the taluk of Cuddalore where the Palur farm, opened in 1905, is situated. The area in this taluk has increased from 180 acres in 1906–07 to 2,000 acres in 1921–22. This is due to the introduction of Red Mauritius from Samalkota. Messrs. Parry & Co. co-operated with the Department in the introduction of Red Mauritius through their sugar factory at Nellikuppam. *Col.* (4).—This represents the difference between the net profits per acre of sugarcane and paddy. The farmers here do not, as a rule, make jaggery themselves but sell canes to the factory.
Do.	Replacement of the local canes by improved varieties.	259	100	25,900	22,600	150	33,90,000	*Col.* (7).—The difference in yield between the improved varieties and the local canes displaced by them is 1,200 lb. of jaggery per acre, the value of which according to present prices is not less than Rs. 150. The area in column (6) relates to the whole Circle except the taluk of Cuddalore and the farmers in this area generally make jaggery themselves. Hence, the gain in column (7) is greater than that in column (4) which refers mainly to the taluk of Cuddalore where the farmers sell canes to the factory at Nellikuppam.
Do.	Reduction in the number of setts planted.	59	60	3,500	13,600	60	8,16,000	The ryots of North Arcot and Chittoor plant as many as 30,000 setts per acre while 10,000 setts are quite sufficient. A saving of 20,000 setts or Rs. 60 per acre can thus be effected.
Do.	Improved furnaces and pans for preparing jaggery.	40	50	2,000	24,400	50	12,20,000	*Col.* (4). There is a saving of Rs. 50 worth of fuel for an acre of sugarcane by using the improved furnace and the thin and wide mouthed pans. The megass and the trash of the cane are used as fuel in the improved furnace.
	Total Sugarcane ...	...		3,91,400	...	...	57,86,000	
	Total IV Circle ...	...	...	8,33,900	...	...	1,28,86,000	The crops dealt with are paddy and sugarcane.

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Crops.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
V Circle (Tanjore and Trichinopoly).—Cultivated area 3,010,000 *acres ; paddy* 1,393,000 *acres ; cotton* 40,900 *acres.*								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy ...	Cultivation of improved varieties.	7,000	About 12½	87,300	160,000 (100,000 in Tanjore, and 60,000 in Trichinopoly.)	12	19,20,000	*Col.* (*3*).—6,500 acres under Red *Samba* 76 in Tanjore; 300 acres under G.E.B. 24 in Trichinopoly. *Col.* (*4*).—Red *Samba* 76 is a selection of Red *Samba* grown at the Manganallur farm. It gives an extra yield of 4 kalams per acre over the ordinary Red *Samba*, i.e., about Rs. 12 per acre.

G.E.B. 24 ripens evenly and earlier than the local varieties, does not shed grain and can resist drought. It is therefore useful in places with a precarious and insufficient supply of water and yields in such places 300—500 lb. per acre over the local varieties, i.e., Rs. 25 per acre.

Col. (*6*).—Red *Samba* 76 is purely a delta variety. There are many other *Samba* varieties, such as white *Sirumani*, Nellore *Samba* and *Sembalai*, besides a large area of "*Udu*" and *Kar* which is grown on high level lands where there is not enough water in November—December to mature a *Samba* crop and therefore an extent of only 100,000 acres has been shown as the possibilities of the extension of Red *Samba* 76.

G.E.B.'s strain 24 may occupy not more than a fifth of the area under irrigated paddy in Trichinopoly as it is advantageous mainly in places with a scanty supply of water. It is a fine variety which is not suited to the needs of the labouring classes.

Paddy ...	Economic transplantation.	375,000	3	11,25,000	950,000	3	28,50,000	*Col.* (3).—Economic planting has become fairly general in Tanjore as a result of the work of the Department for 12 years. At least half the transplanted area is now transplanted economically. In Trichinopoly, economic planting has been adopted in some cases in the Cauvery and Amaravathi basins. But most of the ryots have not yet realized the value of the improvement. *Col.* (6).—Paddy is generally transplanted on wet lands in Tanjore except in the taluks of Pattukottai and Arantangi. Single-planting cannot be adopted in the case of "*Uda.*" About 75 per cent (750,000 acres) of the area under irrigated paddy can be transplanted with single seedlings. In Trichinopoly, *Samba* (both single and second crop) is transplanted while *Kar* and *Kuruvai* are sown broadcast. *Col.* (7).—Rs. 3 is taken on the basis of the present reduced seed rate. This can be reduced still further when the improvement will be worth about Rs, 5 per acre.
Do. ...	Application of fish guano.	1,650	5	8,200	...	...	...	*Col.* (3).—Tanjore—1,250 ; Trichinopoly—400.
Do. ...	Application of manure mixture.	1,000	5	5,000	...	...	...	*Col.* (3).—Tanjore—900 ; Trichinopoly—100.
Do. .	Growing of green manure crops.	17,000 (Tanjore—14,000 ; Trichinopoly—3,000.)	About $6\frac{1}{3}$	1,08,000	500,000 (400,000 in Tanjore and 100,000 in Trichinopoly.)	5	25,00,000	*Col.* (3).—12,500 acres in Tanjore will be under Kolingi collected in the Vedaranniyam tract in the Tiruturaipundi taluk. Seed enough to cover an area of 750 acres in Trichinopoly was distributed by the Department in 1920–21. Besides this, dealers from Râmnâd district stock large quantities of seed in the taluks of Lalgudi and Trichinopoly for sale to ryots. Indigo is also used as green manure. And, finally, there is self-sown *Kolingi* in at least 50 per cent of the fields where there was *Kolingi* in previous years and hence the quantity of seed sold is no indication of the area where *Kolingi* is grown as green manure. *Col.* (6).—Green manures would be confined to the lighter soils in the delta which do not crack in the dry weather. They would be raised on single crop lands which are transplanted and where the usual manures (dung of sheep and cattle, ashes and leaves) are either not available or sufficient. About half the transplanted area may benefit by the application of green manures in the whole Circle. *Col.* (7).—The ultimate gain is reduced to Rs. 5 as it represents the average over a large area.
	Tot l Paddy ...	...	...	13,33,500	...	...	72,70 000	

V Circle (Tanjore and Trichinopoly).—Cultivated area 3,010,000 *acres ; paddy*—1,393,000 *acres ; cotton*—40,900 *acres*—cont.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Cotton	Introduction of Cambodia (irrigated) in Trichinopoly.	3,000	60	1,80,000	3,000	60	1,80,000	*Col.* (4).—See remarks against VIII Circle. The standard of cultivation is below that of the Coimbatore district. Hence the profit is less.
Do.	Cultivation of improved strains of Cambodia (irrigated) in Trichinopoly.	1,000	10	10,000	3,000	10	30,000	The improved strains give a greater yield than the ordinary Cambodia and the cotton commands a higher price owing to its superior quality.
Do.	Cambodia (dry)--prevention of the loss due to the boll-worm insect by the application of Pest Act.	7,000	9	63,000	7,000	9	63,000	See remarks against VIII Circle.
	Total Cotton ...		...	2,53,000	..	...	2,73,000	
	Total V Circle ...	...	...	15,86,500	...	...	75,43,000	The crops dealt with are paddy and cotton.

VI Circle (Madura, Rāmnād, and Tinnevelly).—Cultivated area 4,527,000 *acres ; paddy* 965,000 *acres ; cumbu* 500,000 *acres ; cotton* 650,000 *acres.*

Paddy ..	Application of fish guano in Rāmnād and Tinnevelly.	3,500	5	17,500	...	...	...	*Col.* (3).—Fish guano sufficient for about 900 acres was distributed by the Department in 1920-21. Not less than thrice this area would have been manured by ryots from the stock supplied by private agencies. A large portion of this manure was used for paddy lands in the Tambraparni valley.
Do. ...	Growing of green manure crops.	8,000	15	1,20,000	120,000	15	18,00,000	*Col.* (3).—Green manure seeds sufficient for about 1,600 acres were distributed by the Department in the Periyar tract in 1920-21. The Department has been pushing the worw systematically for a long time with the result that the merchants have set up a regular trade in green manure seeds in this tract and a large area is sown by ryots with seeds privately purchased. *Col.* (4).—In Periyar, at least two cart-loads of green leaf manure costing Rs. 20 are applied to one acre of paddy land. It is very common to bring green leaves in truck-loads about 50 miles by train. It has to be carted to and from the railway at either end before being spread on the field. The cost of growing a green manure crop and pulling and spreading it on the land before ploughing it in is only Rs. 5 per acre. *Col.* (6).—The lands in Rāmnād and Tinnevelly are mostly tank-fed except in the Tambraparni valley where the use of kolingi gathered from the dry lands near the hills is common. The area that can benefit by the application of the green manures will be small. The figure in column (6) relates mainly to the Periyar tract.
	Total Paddy ...	...	...	1,37,500	...	...	18,00,000	

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VI Circle (Madura, Rāmnād, and Tinnevelly).—Cultivated area 4,527,000 *acres; paddy* 965,000 *acres; cumbu* 500,000 *acres; cotton* 650,000 *acres*—cont.								
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Cumbu ...	Drill sowing	1,778	4	7,100	500,000	4	20,00,000	See remarks against drill sowing under cotton.
Cotton ...	Introduction of pure crops of improved strains known as Company cottons, evolved at the Koilpatti farm.	200,000	25	50,00,000	200,000	25	50,00,000	Company cotton yields more than ordinary "Tinnevellies," has a higher ginning percentage, and has a longer and finer staple. It is not possible to forecast what further improvement can be made in Tinnevelly cotton.
Do. ...	Introduction of Cambodia (irrigated).	26,300	60	15,78,000	26,300	60	15,78,000	*Col.* (*3*).—Madura, 9,000; Rāmnād, 14,000; Tinnevelly, 3,300. *Col.* (*4*).—See remarks against VIII Circle. The standard of cultivation is below that of the Coimbatore district. Hence the profit is less.

Cotton ...	Cultivation of improved strains—Cambodia (irrigated).	400	5	2,000	23,000	5	1,15,000	Improved strains of Cambodia have a longer and a stronger staple than that of the crops grown here and therefore command a higher price in the market. They have been introduced in the districts of Madura and Rāmnād.
Do. ...	Drill sowing	6,424	4	25,700	650,000	4	26,00,000	The use of the drill facilitates weeding and, what is much more important, hoeing. *Col.* (*4*).—The gain of Rs. 4 represents the saving in after-cultivation expenses (thinning, weeding along the lines, bullock hoeing, etc.). Neither the saving in sowing expenses nor the increase in outturn due to the preservation of the tilth and the conservation of moisture has been taken into account here. Drill sowing was unknown in Tinnevelly as late as 1906. The usual practice is to sow broad cast and to weed by hand subsequently. *Col.* (*6*).—This represents the area under cotton in the VI Circle.
Do. ...	Cambodia (dry)—prevention of the loss due to the boll-worm insect by the application of the Pest Act.	19,000 in Madura.	9	1,71,000	59,500	9	5,35,500	*Col.* (*3*).—The Pest Act was applied only in Madura. *Co,.* (*4*).—See remarks against VIII Circle. *Col.* (*6*).—This represents the area in the Circle 19,000 acres in Madura, 20,500 in Rāmnād, and 20,000 in Tinnevelly.
Total Cotton ...		...	...	67,76,700	...	..	98,28,500	
Total VI Circle ...		...	...	69,21,300	...	...	1,36,28,500	The crops dealt with are paddy, cumbu, and cotton.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

VII Circle (Malabar and South Kanara).—Cultivated area 2,396,000 *acres; paddy* 1,472,000 *acres; sugarcane* 3,600 *acres; arecanuts* 93,000 *acres.*

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy ...	Cultivation of improved strains (Taliparamba farm seed).	5,000	7	35,000	100,000	7	7,00,000	The strains are selected seeds of local varieties. They ripen uniformly and give better yield. They have been introduced into Calicut taluk and North Malabar. They are spreading naturally, a large portion of the crops grown from seed distributed by the Department having been sold by the ryots for seed. *Col.* (*6*).—The strains are first crop paddies and local conditions vary very much in Malabar. Hence only about a sixth of the first-crop area under paddy may be brought under these strains.
Do. ..	Economic transplantation.	6,000	3	18,000	300,000	3	9,00,000	*Col.* (*3*).—The area under improved strains is transplanted economically, in addition to an extent of 1,000 acres in South Malabar. *Col.* (*6*).—Except in small areas, the first crop cannot be transplanted in South Malabar for want of labour and sufficient water. Again, transplantation is difficult (1) in the sandy soils near the coast and (2) in many of the inland valleys as there is not sufficient labour available for transplanting the crop within the limited time that this operation has to be done. About a third of the area under padly may be transplanted. *Col.* (*7*).—Single-planting is not advocated as paddy seedlings do not tiller well owing to the lack of bright weather during the monsoon. Ryots are advised to plant two or three seedlings according to the fertility of the soil.

Paddy ..	Application of fish manure and fish guano.	1,000	6	6,000	...	...	...	*Col.* (*3*) includes the area manured with fish manure and fish guano purchased by ryots from merchants. The quantity purchased from Government depots alone in 1920–21 was sufficient to manure 685 acres.
Do.	Growing of green manure crops.	300	5	1,500	200,000 (Malabar 100,000; South Kanara 100,000).	5	10,00,000	*Col.* (*3*).—Malabar 50; South Kanara 250. The green manure is Kolingi. *Col.* (*6*).—Green manure crops like Kolingi are specially applicable to the coastal taluks where considerable difficulty is often experienced in collecting green leaves. This is specially the case in South Kanara where green leaves are used for bedding cattle, instead of being applied direct to the land. The area in column (6) represents about a seventh of the area under paddy in the West Coast.
	Total Paddy ...	...	...	60,500	...	...	26,00,000	
Sugarcane.	Extension of area under improved varieties.	1,600	250	4,00,000	1,600	250	4,00,000	*Col.* (*3*).—The Department began to introduce Red Mauritius in 1908–09. Owing to its prolific growth and to its being a hard, jackal-proof cane, the area under sugarcane has increased from 1,978 acres in 1908–09 to 3,600 acres in 1921–22. *Cols.* (*4*) *and* (*7*).—The gain of Rs. 250 per acre represents the difference between the net profits per acre of sugarcane and paddy. The jaggery made in the West Coast is of poor quality and hence the lower price taken here.
Do.	Replacement of the local canes by improved varieties (Red Mauritius, etc.)	2,000	150	3,00,000	2,000	150	3,00,000	The difference in yield between the Red Mauritius and the local varieties displaced by it is 1,500 lb. of jaggery. It is interesting to note that Red Mauritus has spread from South Kanara into North Kanara of the Bombay Presidency.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

VII Circle (Malabar and South Kanara).—Cultivated area 2,396,000 *acres; paddy* 1,472,000 *acres; sugarcane* 3,600 *acres; arecanut* 93,000 *acres*—cont.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Sugarcane —*cont.*	Iron mills for crushing cane.	3,000	50	1,50,000	3,600	50	1,80,000	There are at present 485 iron mills which have almost superseded the country wooden mills. The percentage of juice extracted is considerably higher with the iron mills and this is estimated as the equivalent of 500 lb. of jaggery per acre.
Do.	Improved furnaces and shallow open pans for boiling sugarcane juice.	2,500	25	62,500	3,600	25	90,000	The local pit furnaces are ill-ventilated and the pans are small and deep in shape. The gain of Rs. 25 represents the saving in fuel by using shallow big open pans and by putting up well-ventilated furnaces where the megass and trash from the cane itself are used as fuel. These pans and furnaces are also used for boiling paddy before husking as the grower in South Kanara sells all the produce in the form of boiled rice. This results in a very considerable saving of fuel which has not been estimated.
	Total Sugarcane ...	...	...	9,12,500	...	...	9,70,000	

Arecanuts.	Spraying arecanut bunches with Bordeaux Mixture as a preventive against Mahali disease known as "Koleroga." (*Phytophthora arecae.*)	42,953 trees	2 annas per tree.	5,400	5,200,000	2 annas per tree.	6,50,000	The Mahali disease attacks the tender arecanuts during the monsoon months. *Col.* (*3*) represents the number of trees sprayed in 1916-17 when operations were conducted on a large scale. Since then, several sprayers have been sold to garden owners. About 10,000 trees were sprayed by the Department in 1921-22 at the expense of the garden owners. *Col.* (*6*).—The disease is common in South Malabar, especially in the Ponnani taluk where it formerly caused a loss of some 50 per cent of the crop. The spraying is not a cure but a prophylactic. Incidentally, however, it has generally reduced the incidence of the disease in places where spraying was done in previous years. The figure in column (6) relates to 5,000,000 trees in Malabar and 200,000 trees in South Kanara (mainly in Hannavar magane). A tree bears on an average 200 nuts, the value of which at present prices is 8 to 12 annas.
	Total VII Circle ...	...	...	9,78,400	...	...	42,20,000	The crops dealt with are paddy, sugarcane, and arecanuts.

VIII Circle (Salem and Coimbatore).—Cultivated area 4,305,000 *acres; Paddy* 307,000 *acres; ragi* 550,000 *acres; sugarcane* 15,600 *acres; cotton* 310,000 *acres.*

Paddy ...	Cultivation of improved varieties.	1,000 (Coimbatore—900).	10	10,000	200,000	10	20,00,000	The varieties are G. E. B. 24, 1303, and 91. Strain No. 24 has established itself at Erode and is spreading naturally, a large portion of the crops having been disposed of by the ryots for seed. Strain 91 is a selection from Poombalai. *Col.* (*4*).—The improved strains are of shorter duration than the local varieties and enable the ryots to raise two crops of paddy instead of only one long-duration variety. In a poor season, it is often possible to take a crop of one of these varieties on single crop lands, in the place of the longer duration crop for which there will not be sufficient water. The strains yield better and fetch a higher price than the local varieties. There is also a saving in irrigation charges. The gain is very modestly estimated at Rs. 10 per acre. *Col.* (*6*) represents two-thirds of the area under irrigated paddy in the Circle. The varieties may not suit all conditions.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

VIII Circle (Salem and Coimbatore).—Cultivated area 4,305,000 *acres; paddy* 307,000 *acres; ragi* 550,000 *acres; sugarcane* 15,600 *acres; cotton* 310,000 *acres*—cont.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy—*cont.*	Economic transplantation.	22,000 in Coimbatore.	3½	77,000	220,000 (160,000 Salem; 60,000 Coimbatore.)	3½	7,70,000	*Col.* (*6*).—About five-sixths of the area under irrigated paddy in Salem may be transplanted. Samba in Coimbatore is transplanted whether grown as a single or second crop. *Samba* is the rule as a second crop in places where the irrigation is good. *Col.* (*7*).—Rs. 6 will represent the gain to the ryots by adopting single seedling wherever possible.
Do.	Application of fish guano.	1,300	5	6,500	...	...	...	*Col.* (*3*).—Coimbatore 1,200 acres.
Do.	Application of oil-cakes ...	200 in Salem.	7½	1,500	...	...	..	
Do.	Growing of green manure crops.	8,000	About 19	1,51,800	150,000	15	22,50,000	*Col.* (*3*).—Coimbatore 7,400 acres, mainly under *Kolingi*; Salem 600 acres. *Col.* (*4*).—Ryots apply three cart-loads of leaves collected from either dry lands or from forests. The cost, including carting, is estimated at Rs. 25. The expense of growing a green manure crop is Rs.5 to 10 per acre, including cost of seed, sowing, and cutting. Thus, the gain varies from Rs.15 to 20 per acre. *Col.* (*6*).—Green manures would be confined largely to single crop lands which are transplanted. The area under irrigated paddy in the Circle is 300,000 acres. This area includes both double cropped and broad casted lands. Village sweepings and cattle droppings in Coimbatore are required for garden lands or for dry fields when there are no gardens. *Col.* (*7*).—The ultimate gain is put at the minimum as it represents the average over a large area.
	Total Paddy ...	...	...	2,46,800	...	...	50,20,000	

Ragi ...	Introduction of Hagari No. 8.	250	2	500	40,000	2	80,000	Hagari No. 8 is a strain of ragi from the Bellary district. It yields better than the local variety. *Col.(6)* represents about 10 per cent of the area under unirrigated ragi in the Circle.
Sugarcane.	Improved furnaces for jaggery-making in Coimbatore.	200	25	5,000	97,000	25	2,42,500	The furnaces are on the Sindewahi model.
Cotton ...	Introduction of Cambodia (irrigated), a new crop.	86,800 (Coimbatore, 84,000).	80	69,44,000	86,800	80	69,44,000	Cambodia cotton is an exotic and was introduced by the Department in 1904. It did not replace any indigenous cotton. It is cultivated mainly on land which had previously yielded precarious crops of paddy, on very favourably situated dry land or introduced into the rotation of garden crops. Thus, Cambodia supplanted crops the average profits of which could not have been more than Rs. 40 to 50 per acre. Cambodia requires less irrigation than any other garden crop. A good crop on irrigated and heavily manured land will yield about 500 lb. of lint per acre and even more. It is superior to indigenous cotton in yield, in ginning percentage, in the quality of the lint, and in price. On a modest estimate a net profit of Rs. 120 to 130 per acre can be obtained at present prices. This means a gain of Rs. 80 per acre over the crops that would otherwise be grown.
Do.	Cultivation of improved strains of Cambodia (irrigated).	21,500 (Coimbatore, 20,000).	10	2,15,000	86,800	10	8,68,000	*Col. (4)* represents the gain from (1) the extra yield (25 lb. of *kapas* per acre), (2) the higher price paid for quality and (3) the saving in seed which has been reduced from 25 lb. to 15 lb. per acre, on account of the better quality of the seed.
Do.	Cambodia (dry)—prevention of the loss due to the pink boll-worm insect by the application of the Pest Act.	32,000 (Coimbatore, 29,000).	9	2,88,000	32,000	9	2,88,000	The pink boll-worm feeds inside the green bolls and damages the vital parts with the result that the bolls often drop to the ground. It stains and weakens the cotton fibre and dirties the cotton. The damage on account of this insect is estimated to consist of a reduction (1) of 11 per cent lint for the season picking and 27 per cent for the summer picking, (2) of 15 per cent seed and (3) in price to the extent of Rs. 25 a bale. As a result of the application of the Pest Act, the cotton crop of the current season is reported to be excellent and free from the attack of the boll worm. The loss prevented in the case of dry Cambodia is not less than Rs. 9 per acre.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

VIII Circle (*Salem and Coimbatore*).—*Cultivated area* 4,305,000 *acres* ; *paddy* 307,000 ; *ragi* 550,000 *acres* ; *sugarcane* 15,600 *acres* ; *cotton* 310,000 *acres*—cont.

		ACS.	RS.	RS.	ACS.	RS.	RS.	
Cotton—*cont.*	Introduction of Company cotton in Coimbatore.	4,000	30	1,20,000	29,000	30	8,70,000	*Col.* (*3*) represents only the area for which the seed has been supplied by the Department. The natural expansion of the cultivation of Company cotton (*Karunganni*) in Coimbatore is much greater. The *Karunganni* crop is variously estimated at from 20,000 to 40,000 bales of 400 lb. in this Circle. This represents the produce of 80,000 to 160,000 acres, at the rate of 100 lb. of lint per acre. *Col.* (*4*) epresents the difference between the net profits per acre of Company cotton and dry Cambodia in Coimbatore. The yield of Cambodia on dry soil is low. *Col.* (*6*) represents the area in 1921–22. The area under dry Cambodia in Coimbatore was as high as 156,000 acres in 1918–19 when the price of Cambodia was very high.
	Total Cotton ...	...	...	75,67,000	...	...	89,70,000	The Department has not attempted till now any district work in the Nilgiris which is also in the VIII Circle. Work on potatoes and fruits is being taken up now. The crops dealt with in the Circle are paddy, ragi, sugarcane, and cotton.
	Total VIII Circle ...	...	...	78,19,300	...	...	1,43,12,500	

Summary—Presidency figures.—Cultivated area 38,992,000 *acres; paddy* 11,362,000 *acres; cholam* 5,171,000 *acres; cumbu* 3,505,000 *acres; ragi* 2,489,000 *acres; sugarcane* 106,000 *acres; cotton* 2,272,000 *acres; turmeric* 42,500 *acres; plantain* 124,000 *acres; arecanut* 117,300 *acres.*

Paddy ...	Cultivation of improved strains and varieties.	29,000	8	2,27,800	870,000	About $9\frac{1}{2}$	82,50,000	*Cols.* (4) *and* (7).—The figures in the two columns will be different as they represent the averages of two different sets of figures. Improved strains and varieties have been introduced in I, IV, V, VII and VIII Circles. The ryots not only select seed from the crop grown and keep it for their own needs but sell a portion of the surplus to others for seed at a premium. Thus, the area under improved strains will increase year after year.
Do.	Economic transplantation, including single-seedling.	195,300	About 3	18,67,700	3,100,000	About $3\frac{1}{6}$	95,15,000	Work has been done except in the II and VI Circles. *Cols.* (7) *and* (8).—The figures are based on the present reduced seed-rate. This can be reduced still further when the improvement will be worth about Rs. 1,50,90,000 without taking the increase in yield into account.
Do.	Application of concentrated manures.	11,750	About $5\frac{3}{4}$	68,700	1,250,000	5	62,50,000	Concentrated manures consist of bone-meal, fish manures, and oil-cakes. 169,000 tons of these manures were exported by sea and rail to places outside the Madras Presidency on an average during the three years ending with 1920-21. The quantity includes also the oil-cake content of the exported oil seeds. These manures could have been applied to an extent of 1,250,000 acres of paddy at the rate of about 300 lb. per acre if their export were stopped and would have yielded a net profit of Rs. 5 per acre at a very modest estimate.

Summary—Presidency figures.—Cultivated area 38,992,000 *acres; paddy* 11,362,000 *acres; cholam* 5,171,000 *acres; cumbu* 3,505,000 *acres; ragi* 2,489,000 *acres; sugarcane* 106,000 *acres; cotton* 2,272,000 *acres; turmeric* 42,500 *acres; plantain* 124,000 *acres; arecanut* 117,300 *acres*—cont.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		ACS.	RS.	RS.	ACS.	RS.	RS.	
Paddy—*cont.*	Growing of green manure crops.	45,300	About 10	4,64,300	2,650,000	About 6½	1,70,00,000	There are several kinds of green manures suitable to various types of lands. The cultivator does not now entirely depend on the Department for the supply of green manure seeds. He either grows his own green manure seeds or purchases them from private merchants who have established a regular trade. The area in column (6) represents about one-third (32 per cent) of the area under irrigated paddy in the Presidency.
	Total Paddy ...	...	...	26,28,500	...	...	4,10,15,000	
Cholam ...	Cultivation of selections from local cholam in the Ceded Districts.	2,450	3	7,300	350,000	3	10,50,000	
Do.	Anti-smut operations in the Ceded Districts.	47,450	1½	71,200	2,000,000	3	60,00,000	The operations consist in steeping cholam seed in a solution of copper sulphate to prevent the attack of smut.
	Total Cholam ...		...	78,500	...	...	70,50,000	

Cumbu ...	Drill sowing	1,778	4	7,100	500,000	4	20,00,000	The figures relate to Madura, Rāmnād, and Tinnevelly.
Ragi ...	Introduction of Hagari No. 8 in Salem and Coimbatore.	250	2	500	40,000	2	80,000	
Sugarcane.	Extension of area under improved varieties.	11,500	277	31,90,000	11,500	277	31,90,000	The figures relate mainly to the districts of Gōdāvari, South Arcot, and South Kanara.
Do.	Replacement of the local canes by improved varieties.	7,559	183	13,85,900	51,200	176	90,10,000	The figures relate to I, IV, and VII Circles.
Do.	Planting canes in lines and reducing the seed rate.	159	63	10,000	64,800	64	41,44,000	The figures relate to the Circars and to the districts of North Arcot and Chittoor.
Do.	Introduction of iron mills for crushing cane.	3,000	50	1,50,000	3,600	50	1,80,000	The figures relate to the West Coast. The local wooden mills have now been displaced by iron mills.
Do.	Introduction of improved furnaces and pans.	2,770	About 25	70,200	37,900	41	15,57,500	The figures relate to the districts of Kurnool, Chingleput, South Arcot, North Arcot, Chittoor, Coimbatore, Malabar, and South Kanara.
	Total Sugarcane ...	...	..	48,06,100	...	...	1,80,81,500	
Cotton ...	Cultivation of improved strains and varieties.	242,000	About 20¾	50,35,000	1,200,000	7¾	93,00,000	The improved strains and varieties are N. 14 and H. 25 in the Deccan and Company cottons in Madura, Rāmnād, and Tinnevelly.
Do. ...	Introduction of Cambodia (irrigated).	116,100	About 75	87,02,000	116,100	About 75	87,02,000	Cambodia (irrigated) is an exotic and has been introduced as a new crop in the districts of Salem, Coimbatore, Trichinopoly, Madura, Rāmnād, and Tinnevelly.

Summary—Presidency figures.—Cultivated area 38,992,000 *acres*; *paddy* 11,362,000 *acres*; *cholam* 5,171,000 *acres*; *cumbu* 3,505,000 *acres*; *ragi* 2,489,000 *acres*; *sugarcane* 106,000 *acres*; *cotton* 2,272,000 *acres*; *turmeric* 42,500 *acres*; *plantain* 124,000 *acres*; *arecanut* 117,300 *acres*—cont.

Crop.	Nature of the improvement.	Area under the improvement.	Estimated gain per acre.	Total estimated gain per annum.	Possible area under the improvement.	Estimated gain per acre.	Possible estimated gain.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		ACS.	RS.	RS.	ACS	RS.	RS.	
Cotton —*cont.*	Cultivation of improved strains of Cambodia (irrigated).	22,900	About 10	2,27,000	112,800	About 9	10,13,000	The figures relate to Salem, Coimbatore, Trichinopoly, Madura, and Rāmnād.
Do. ...	Introduction of Company cotton (*Karungani*) in Coimbatore.	4,000	30	1,20,000	29,000	30	8,70,000	Company cotton is replacing dry Cambodia, which is a poor yielder.
Do. ...	Drill sowing	6,424	4	25,700	650,000	4	26,00,000	The figures relate to Madura, Rāmnād, and Tinnevelly.
Do. ...	Cambodia—(dry)prevention of the loss due to the boll-worm insect by the application of the Pest Act.	58,000	9	5,22,000	98,500	9	8,86,500	The figures relate to the V, VI, and VIII Circles.
	Total Cotton ...	..	...	1,46,31,700		...	2,33,71,500	
Turmeric.	Introduction of improved furnaces in Guntūr.	15	10	150	5,200	10	52,000	
Plantain ...	Introduction of the improved method of cultivation in the Gōdavāri district.	340	300	1,02,000	6,900	300	20,70,000	

Palmyra ...	Operations against the bud-rot disease of palmyras in the districts of Gōdāvari and Kistna.	500,000 trees.	Rupee one per tree.	5,00,000	500,000 trees.	Rupee one per tree.	5,00,000
Arecanut.	Spraying arecanut bunches with Bordeaux Mixture as a preventive against Mahali disease known as " Koleroga."	42,953 trees.	Two annas per tree.	5,400	5,200,000 trees.	Two annas per tree.	6,50,000
	Grand total ...	...	...	2,27,59,950	...	...	9,48,70,000

Gain (both present and prospective) to the ryots in each Circle by following the advice of the Department of Agriculture
(The figures in the numerator below give an estimate of the present gain, while the figures in the denominator give an estimate of the prospective gain.)

Name of crop.	I Circle.	II Circle.	III Circle.	IV Circle.	V Circle.	VI Circle.	VII Circle.	VIII Circle.	Total.	Nature of improvements recommended, etc.
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	
Paddy ...	3,95,100 / 92,35,000	4,500 / 15,00,000	8,100 / 2,40,000	4,42,500 / 71,00,000	13,33,500 / 72,70,000	1,37,500 / 18,00,000	60,500 / 26,00,000	2,46,800 / 50,20,000	26,28,500 / 4,10,15,000(*a*)	Cultivation of improved strains and varieties, economic transplantation including single seedling, application of concentrated manures, and growing of green manure crops.
Cholam ...	...	...	78,500 / 70,50,000	...	...	...	...	...	78,500 / 70,50,000	Cultivation of selections of local varieties and anti-smut operations.
Cumbu ...	...	...	...	...	...	7,100 / 20,00,000	...	...	7,100 / 20,00,000	Drill sowing.

(*a*) The total prospective gain includes a profit of Rs. 62,50,000 from the application of concentrated manures which it is not easy to apportion among the Circles and which has therefore not been included in the Circle figures.

Ragi	...	...	...	...	...	...	...	500 / 80,000	500 / 80,000	Cultivation of improved varieties.
Sugarcane.	34,96,500 / 1,10,78,000	... / ...	700 / 5,000	3,91,400 / 57,86,000	... / ...	... / ...	9,12,500 / 9,70,000	5,000 / 2,42,500	48,06,100 / 1,80,81,500	Extension of area under improved varieties (Red Mauritius, etc.), replacements of the local canes by improved varieties, planting canes in lines and reducing the seed-rate, replacement of wooden mills by iron mills for crushing sugarcane, and the introduction of improved furnaces and pans for boiling the juice.
Cotton ...	...	...	35,000 / 43,00,000	...	2,53,000 / 2,73,000	67,76,700 / 98,28,500	...	75,67,000 / 89,70,000	1,46,31,700 / 2,33,71,500	Cultivation of improved strains and varieties (N. 14, H. 25 and Company cottons), introduction of Cambodia (irrigated), cultivation of improved strains of Cambodia (irrigated), introduction of Company cottons in Coimbatore, drill sowing of cotton, and prevention of the loss due to the pink boll-worm insect by the application of the Pest Act.
Turmeric...	..	150 / 52,000	...	...	...	...	...	..	150 / 52,000	Introduction of improved furnaces for drying the stuff.

Gain (both present and prospective) to the ryots in each Circle by following the advice of the Department of Agriculture (The figures in the numerator below give an estimate of the present gain, while the figures in the denominator give an estimate of the prospective gain).

Name of crop.	I Circle.	II Circle.	III Circle.	IV Circle.	V Circle.	VI Circle.	VII Circle.	VIII Circle.	Total.	Remarks.
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS	
Plantain.	1,02,000 / 20,70,000	...	...	...	...	...	...	...	1,02,000 / 20,70,000	Introduction of the improved method of cultivation (South Indian system) in the Godavari district.
Palmyra.	5,00,000 / 5,00,000	...	...	...	...	...	...	...	5,00,000 / 5,00,000	Operations against the bud-rot disease.
Arecanut.	...	...	...	...	...	...	5,400 / 6,50,000	...	5,400 / 6,50,000	Operations against the Mahali disease.
Total ...	41,93,600 / 2,28,83,000	4,650 / 15,52,000	1,22,300 / 1,15,95,000	8,33,900 / 1,28,86,000	15,86,500 / 75,43,000	69,21,300 / 1,36,28,500	9,78,400 / 42,20,000	78,19,300 / 1,43,12,500	2,27,59,950 / 9,48,70,000(a)	

(a) See remarks against (a) at page 110.

APPENDIX B.

List of Publications of the Madras Agricultural Department.

Note for the Vernacular Press.

1908 1. Agricultural College, Coimbatore.
2. On the sowing of paddy.
3. Green manure.
4. Lime cultivation.
5. Coimbatore Agricultural College.

1909 1. The use of drill for sowing cotton.
2. Seed selection, etc.

1910 1. On pepper.
2. On the improvement of plants.
3. Cambodia cotton.
4. The best time to visit the Palur Agricultural Station.

1911 ... Revised note on Cambodia cotton.

1913 1. List of insect pests of cultivated plants in Southern India.
2. Note on the preparation of Bordeaux mixture for the treatment of Mahali disease.

Leaflets.

1909 1. Banku paddy.
2. Uses of the harrow.
3. Cotton cultivation.
4. Single planting of paddy.

1910 1. Manuring in the Kistna Delta
2. Groundnut cultivation on the West Coast.
3. Method of preparing preserved ginger.
4. Single Seedling planting of paddy.
5. Green manuring.
6. A note on Hairy Caterpillars.
7. A Summary Note on the Swarming Caterpillar Pest of Paddy in North Malabar.
8. Note on The Conservation of Cattle Urine.
9. Experiences of Single Seedling Planting.
10. Useful Facts Learnt From the Agricultural Station at Palur, Near Nellikuppam, South Arcot District.
11. Do. at the Taliparamba Agricultural Station.
12. Light Traps.
13. (Single) Planting 8 Feet Apart, and Manuring of Individual Plants.
14. Practical lessons learnt from the Experiments at the Central Farm.
15. Useful facts learnt at Kōilpatti.

1911 1. Instructions For Sending Plants Attacked By Parasitic Fungi To The Office of the Government Mycologist, Coimbatore.
2. Note on Sugarcane Cultivation on the West Coast.
3. A dialogue on Single Planting Paddy.
4. A note on wild indigo.
5. *Bambuchu* and How To Combat it.
6. Improvements in Ryots' Land.
7. Advantages of using iron ploughs in black cotton soils.
8. Coconut Beetle.

9. Manuring in the Kistna Delta.
10. Dhaincha (*Takkapunda*).
11. Cambodia Cotton.
12. The Potato Crop.
13. Sugarcane Cultivation on the West Coast.
14. The Preservation of Farm-yard Manure.
15. Bud-rot in Gōdāvari and Kistna districts.
16. Leaflet For Small Ginning Factories.
17. Cambodia cotton. The importance of sowing pure seed.
18. Improvements in Paddy Cultivation Recommended by the Department.
19. Cotton.
20. Improvements which can be effected in the Sugarcane Cultivation of South Kanara.
21. Sugarcane.
22. Jaggery Making.
23. The Cultivation of Ginger on the West Coast.
24. Paddy manuring.

1912 1. The methods of Reclaiming Saline Soils.
2. Note on the Agricultural College, Coimbatore.
3. On the Deccan Grasshopper Pest.
4. The Bud-rot of Palmyras in Gōdāvari and Kistna Districts.

1913 1. What the Ryot Has To Say About Single Seedling Planting of Paddy.
2. Insect Pests.
3. What the Ryot Has To Say About The Use of the Drill For Sowing Seed.
4. Flies Spoiling Toddy in South Kanara.
5. Training of Practical cultivators, Maistris or Field Coolies.
6. What the Ryot Has To Say About Single Seedling Planting of Paddy.
7. The Mahali Disease of Areca Nuts.
8. Castration and Mulling.
9. The Single seedling Transplanting of Paddy.
10. The bud-rot of Coconuts in Malabar district.
11. Ill effects of Communal Grazing.

1914 1. Practical Instructions for the Kollegal Mulberry—Silk-worm Rearers.
2. The advantages of co-operative sale of cotton.
3. Some General Methods of Controlling Attacks by Insect Pests, Agricultural methods.
4. Some General Methods of Controlling Attacks by Insect Pests, Mechanical methods.
5. The Fodder Question in Coimbatore.
6. A Dialogue on the Cultivation of Cambodia.
7. The Mahali or Koleroga Disease of Arecanuts.
8. Possible use for oil-engines when Not required for Pumping.
9. Indigo.

1915 1. What the ryot has to say about the advantages of growing dhaincha as a green manure crop for paddy lands.
2. Do. do. wild indigo as a green manure for wet land.
3. Do. do. uses of triangular harrow sold to the Ryots from the Agricultural Station, Palur (Near Nellikuppam), South Arcot district.

4. Pulichai, Mailam or Jari cotton in Tinnevelly and Rāmnād districts.
• 5. Water hyacinth.
6. Compressed Air Sprayer For Spraying Arecanuts.
7. List of Agricultural Implements recommended by the Department.
8. Method of Collecting and Dressing kolingi seed before sowing.

1916 1. Experience of Mr. Kallichitti Abbayi Nayudu of Pulla, Kistna district on green manure.
2. Some Uses of Prickly-pear.
3. Ground-nut cultivation in the upland taluks of the Gōdāvari district.
4. Pulichai, Mailam or Jari cotton in Tinnevelly and Rāmnād districts.
5. Pulichai, Mailam or Jari cotton.

1917 1. Guinea Grass.
2. Lucerne.
3. The Mango Hopper Pest and its Control.
4. Possible Improvements in the Manufacture of Indigo in the Madras Presidency.
5. A few home-made remedies against some common plant pests.
6. Green manure crops suitable for the Northern Circars and the Ceded Districts.
7. Green manure crops suitable for the Tamil districts.
8. Sorghum for fodder on the black soils of Bellary district.
9. The coconut.
10. Songs on improved methods of paddy cultivation.
11. Songs on preventive methods to protect mango flowering.
12. Hints to the ryots of the IV Circle on green manuring.

1918 1. Instructions for reporting insect damage and forwarding specimens for examination.
2. The insect pests of tobacco in South India.
3. Certified drivers for ryots' pumping engines.
4. How to increase the yield of crops (Agricultural song).
5. Faulty flaying of hides and the branding of cattle.
6. Graft mangoes, how to start and maintain a mango garden.

*1. Rice Hispa.
2. Hairy Caterpillar.
3. Control of important paddy pests.
4. Cambodia cotton.
5. The cultivation of Cambodia cotton in the Ceded Districts.
6. Sugarcane cultivation for the use of the ryots of the IV Circle.
7. Tapioca cultivation.
8. Bud-rot of palmyra and coconut palms in Gōdāvari and Kistna districts.
9. How to increase production of crops.
10. Note on pepper cultivation.

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* From 1919, leaflets are being numbered in one continuous series, instead of separately for each year.

11. Note on the cultivation of Modan Paddy.
12. Note on sugarcane cultivation on the West Coast.
13. The present state of the Mulberry Silk-worm Industry of the Madras Presidency and its possible improvements.
14. Note on Monsoon Plough.
15. Coconut Stem-bleeding Disease.
16. Note on mildew on grapes and how to prevent it.

Bulletins.

1. Essays on Viticulture and Fruit Culture in California.
2. Papers on the tobacco parasite Bodu, or *Orobanche nicotiana*.
3. Forecast of Outturn of early-sown indigo, paddy, etc., 1889.
4. Native method of cultivating and curing tobacco, etc., in Madura.
5. Report on the Sowings of Late crops, 1889–90.
6. South Indian Fodders by Dr. Van Geyzel and C. Benson.
7. Forecast of Outturn of Late Crops, Paddy, Indigo, etc., 1889–90.
8. The supply of Cattle in the Madras Presidency by E. H. Hazelton and C. Benson.
9. Cotton in the Madras Presidency.
10. The Storage of Seed Grain in the Cuddapah and Kurnool districts by C. Benson.
11. Fields of demonstration in France—Extracts from a Ministerial circular.
12. Forecast of Sowings of Early Crops of Paddy, Indigo, etc., for 1890.
13. Report on the Late Sowings of the Gingelly Crops for 1890–91.
14. Forecast of the Outturn of the Early Sown Paddy, Indigo, and Gingelly crops of 1890.
15. Forecast of the Late Sown Paddy and Indigo of 1890–91.
16. Forecast of the Outturn of Early and Late Sown Cotton Crops for 1890–91.
17. Forecast of the Outturn of Early and Late Sown Cotton Crops for 1890–91.
18. Forecast of the Outturn of the Late Sown Paddy and Indigo Crop for 1890–91.
19. The growth of Cotton in Tinnevelly—Report by S. Pranatartihara Ayyar.
20. Forecast of the Outturn of the Late Sown Gingelly Crop for 1890–91.
21. The Cultivation of Rice in Italy—Extracts translated by C. J. Peters.
22. Telugu Sayings and Proverbs—Collection of—by C. Benson.
23. The scrub Exterminator—Collection of reports regarding.
24. Names of Field Crops of the Madras Presidency.
25. The Palmyra Palm and its uses by W. A. Symonds with notes by C. K. Subba Rao.
26. Sugar Mills by C. Benson.
27. Grass-Farming in Coimbatore.

28. The Ground, Earth, or Pea-nut (*Arachis Hypogæa*).
29. The cultivation and manufacture of Ganja in Madras.
30. Note on the Extraction of *Agave Americana* fibre at Coimbatore.
31. The care and management of Farm-manure in South India.
32. Experiments With Water-lifts.
33. On the use of iron ploughs in the Ceded Districts.
34. Tamil Sayings and Proverbs on Agriculture.
35. Water-lifts by Chatterton.
36. A Sugarcane Pest in Madras.
37. The ground-nut (*Arachis Hypogæa*).
38. The ground-nut crops growing near Panruti in South Arcot.
39. The Sugarcane in South Arcot district.
40. The Seed Drill and Other Implements Used in connexion therewith.
41. The Ground-Nut Crop (A report on certain analysis of the ground-nut).
42. Native Beliefs Regarding The Hairmarks on Horses and Cattle.
43. Sugarcane in the Gōdāvari and Ganjām districts.
44. Notes on the Cattle of the Madras Presidency.
45. A Tea Eel-worm Disease in South India.
46 The sugarcanes of Madras.
47. Note on Simple Machines for Extracting Plantain Fibre (Bulletin No. 77).
48. Note on the Experimental Sugarcane Station at Samalkota, Gōdāvari District.
49. Diseases of *Andropogon Sorghum* in the Madras Presidency.
50. Sugarcane Cultivation in the Deccan Districts of the Madras Presidency.
51. Progress Report on the Work of the Samalkota Experimental Sugar Farm during 1903–04.
52. The Agathi Plant.
53. The Cultivation and Curing of Tobacco as followed near Dindigul.
54. Note on Irrigation by Pumping From a Well at Melrosapuram.
55. The Great Millet or Sorghum in Madras.
56. The Varieties of Cultivated Pepper.
57. Note on Fig Cultivation in Southern India and Peculiarities in Viticulture in Penukonda.
58. The Cultivation of Ground-nuts.
59. Sunnhemp (*Crotalaria Juncea*).
60. Cattle of Southern India.
61. Improvements in Paddy Cultivation on the Home Farm at Sivagiri.
62. Note on the Home Farm, Sivagiri Estate, Tinnevelly district.
63. Principles of Paddy Manuring.
64. Hindupur Agave Plantation.
65. Note on the Indigenous Manures of Southern India and their application.

66. The Manuring of Sugarcane at Samalkota Agricultural Station, 1902—1912.
67. Note on the Insects attacking the Paddy Plant in Southern India.
68. A Soil Survey of the Tanjore delta.
69. Bees and the Fertilization of Coffee.
70. A Soil Survey of the Guntūr delta.
71. Irrigation.
72. A Brief Survey of the Madras Live-stock.
73. A Survey of the Madras Dairy Trade.
74. Indigo Manufacture in Madras.
75. A Soil Survey of the Kistna delta.
76. Exhibit of Food and Industrial Products made from local agricultural produce at the Madras Industrial Exhibition, December 1917.
77. Note on Simple Machines for Extracting Plantain Fibre.
78. Note on Tobacco Cultivation in Gōdāvari Lankas.
79. Some Aspects of Dairying at the Madras Agricultural College, Coimbatore.
80. The Entomologist's Crop Pest Calendar for the Madras Presidency.
81. Bird Friends and Foes of the Farmer.
82. A Note on Casuarina Plantations in the Vizagapatam District.
83. A Soil Survey of the Gōdāvari delta.

Year Book.

1917, 1918, 1919, 1920–21.

The Villagers' Calendar (formerly called the Agricultural Calendar) in English, Tamil, Telugu, Malayalam, and Kanarese, 1910, 1911–12, 1912–13, 1913–14, 1914–15, 1915–16, 1916–17, 1917–18, 1918–19, 1919–20, 1920–21, 1921–22.

PUSA MEMOIRS.

Botanical Series.

(1) Vol. VII, No. 1. Studies in Indian Sugarcanes, No. I, Punjab canes, by C. A. Barber, D.Sc.

(2) Vol. VII, No. 3. Studies in Indian Sugarcanes, No. II, Sugarcane Seedlings, including some Correlations between Morphological Characters and Sucrose in the Juice, by C. A. Barber.

(3) Vol. IX, No. 2. The Inheritance of Characters in Rice I, by F. R. Parnell, B.A., G. N. Rangaswami Ayyangar, B.A., K. Ramayya, L.Ag.

(4) Vol. IX, No. 4. Studies in Indian Sugarcanes, No. III. The classification of Indian Canes with special reference to *Sarethu* and *Sunnalile* groups, by C. A. Barber, D.Sc.

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(1) Vol. V, No. VI. Lantana Insects in India. Being the reports of an inquiry into the efficiency of indigenous insect pests as a check on the spread of lantana in India, by Rao Sahib Y. Ramachandra Rao, M.A., F.E.S.

Pusa Bulletins.

(1) Bulletin No. 58. *Calocoris angustatus*, Leth., by E. Ballard, B.A., F.E.S.

(2) Bulletin No. 83. Progress of the Sugarcane Industry in India during the years 1916--1917. Being notes submitted to the Meeting of the Board of Agriculture in India, Pusa, 1917. Edited with an Introduction, by C. A. Barber, C.I.E., D.Sc., F.L.S.

(3) Bulletin No. 87. A contribution to our knowledge of some South Indian Coccidae, by T. V. Ramakrishna Ayyar, B.A., F.E.S., F.L.S.

(4) Bulletin No. 94. A Preliminary Note on the Behaviour in North India of the first batch of Sugarcane seedlings distributed from the Sugarcane breeding station, Coimbatore, by T. S. Venkataraman, B.A.

(5) Bulletin No. 97. *Ustilago crameri* Koern, on *Setaria italica*, Beauv, by S. Sundararaman, M.A.

Articles contributed to the Agricultural Journal of India *by Officers of the Madras Agricultural Department.*

1906 1. The Origin of New Sugarcanes by Bud variation, by C. A. Barber.
2. The Production of Early Maturing Canes, by C. A. Barber.
3. The Samalkota Sugarcane Farm, by C. A. Barber.

1907 4. Report of the Agricultural Station, Palur, for 1905-06, by C. A. Barber.
5. Sugarcane Cultivation in the Irrigated Lands of the Gōdāvari Delta, by C. A. Barber.

1908 6. Leaf Manuring in South Kanara, M. E. Couchman.
7. A comparative test between Iron and Wooden Sugar Mills, by R. C. Wood.
8. Fish Manure in Madras, by C. K. Subba Rao.
9. The Nendram Plantain of the Madras West Coast, by C. K. Subba Rao.
10. The Seed of *Nymphaea Latus*, by C. K. Subba Rao.
11. Tobacco in South Kanara, by C. K. Subba Rao.
12. Note on some Sheep found near Cumbam, by R. C. Wood.

1909 13. Management of Experiment Stations in India, by H. C. Sampson.
14. The Introduction of Drill-Sowing and Inter-Cultivation on the Black Cotton Soils of Tinnevelly, by H. C. Sampson.

1910 15. School Gardens, by M. E. Couchman.
16. The College of Agriculture, Coimbatore, by R. C. Wood.

1911 17. Difficulties in the Improvement of Indian Agriculture, by M. E. Couchman.
18. The Introduction and Spread of Cambodia Cotton in the Madras Presidency, by H. C. Sampson.
19. Note on an Exhibition case, by R. C. Wood.

1912 20. Heavea Rubber in Southern India, by R. D. Anstead.
21 Mimosa Pudica in Coorg, by C. A. Barber.
22. Seedling Canes in India, by C. A. Barber.
23. Cabbage White Butterfly, by T. B. Fletcher.
24. Termites or White Ants, by T. B. Fletcher.
25. Rows of Spots on the Leaves of Palmyra Palms, by W. McRae.
26. Extraordinary Growth of Cane, by R. C. Wood.

1914 27. The Bud-rot of Coconut Palms in Malabar, by F. J. Shaw and S. Sundararaman.

28. Sub-Soil Drainage in Paddy Lands, by. R. C. Wood.
29. The Use of Fish as Cattle Food, by R. C. Wood.

1915 30. Improvement of Cane Cultivation in the South Kanara district, by H. C. Sampson.
31. Sugar and the Sugarcane, by C. A. Barber.
32. Paddy Seed-beds in the Kistna delta, by D. Ananda Rao.
32A. Recent History of the Cotton Improvement Work in Tinnevelly and Rāmnād districts, by H. C. Sampson, B.Sc.
33. Mango Hopper Control Experiments, by E. Ballard.

1916 34. A Note on the Inheritance of certain stem characters in *Sorghum*, by G. R. Hilson.
35. The Classification of Indigenous Indian Canes, by C. A. Barber.

1918 35A. Testing new Cane-seedlings in India, by C. A. Barber.
36. Daily Variation in the composition of Milk, by D. Ananda Rao.
37. Manuring of *Heavea Brasiliensis*, by R. D. Anstead.
38. Treatment of fungoid Diseases on Estates, by R. D. Anstead.
38A. Study of arrowing in the Sugarcane.

1919 39. Improvement of Tinnevelly's Cotton, by R. Thomas.
40. Improvement of Coffee by seed selection and hybridization, by R. D. Anstead.
41. Coffee Planting Industry in South India, by R. D. Anstead.
42. Prevention of Soil Erosion on Tea estates in South India, by R. D. Anstead.
43. Sugar as a coagulant for Heavea Latex, by R. D. Anstead.
43A. Study of Sucrose variations in successive cane joints.
44. Some Foreign Insect Pests which we do not want in India, by T. V. Ramakrishna Ayyar.
45. Northern Cotton, by G. R. Hilson.
46. A Disease of Para Rubber Trees, caused by *Phytophthora* Meadii, by W. McRae.
47. Blast of Paddy, by W. McRae.
48. Dairy Industry around Coimbatore, by D. Ananda Rao.
49. Effect of Salinity on the Growth and Composition of Sugarcane varieties, by K. Krishnamurti Rao.
50. Some Factors which influence the yield of Paddy in comparative manurial experiments at the Manganallūr Agricultural Station, by H. C. Sampson.
51. Studies in the Chemistry of Sugarcane, by B. Viswanath.
52. Intermittent bearing of Fruit Trees, by T. S. Venkataraman.
52A. Experimental Error in variety tests with rice, by F. R. Parnell.
53. Some Agricultural Aspects of the Hosur Remount Depot, by R. C. Wood.

1920 54. A Note on *Heliothis* (*chloridea*) *obsoleta* as a pest of cotton, by E. Ballard.
54A. Note on the Exhaustion of Indian Soils and the Methods by which this may be remedied, by R. V. Norris.
55. Habit in Sugarcanes, by U. Vittal Rao.

56. Some aspects of Cotton Improvement in India, by H. C. Sampson.
57. A few Hints on Labelling in Experimental Stations, by T. S. Venkataraman.
58. Packing Seed Sugarcanes for transport, by T. S. Venkataraman.

1921 59. The Care and Treatment of new Sugarcane Importations, by T. S. Venkataraman.
60. Some local Practices prevalent in South India in the Control of Insect pests, by T. V. Ramakrishna Ayyar.
61. Some Rice-breeding experiments, by G. N. Rangaswami Ayyangar.
62. Cambodia Cotton (*Gossypuim hirsutum*): Its deterioration and improvement, by G. R. Hilson.
63. Uniformity of length of Cotton Hairs, by G. R. Hilson.
64. A simple Pollinating Apparatus, by T. S. Venkataraman.
65. Enzymes of the germinating Red-gram, by B. Viswanath.
66. Exhibits of the Madras Industrial Exhibition, by M. R. Ramaswami Sivan.
67. Improvement of the Coconut Jaggery Industry on the West Coast, by R. V. Norris, B. Viswanath and Govinda Nayar.

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